REPORT OF
THE SELECTED BUILDINGS PROJECTS TEAM
ON
MULTISTOREYED BUILDINGS

COMMITTEE ON PLAN PROJECTS
NEW DELHI

December, 1958.

Composition of the Committee on Plan Projects for Public Works and Building Sector of the Second Five Year Plan

Chairman

Shri Govind Ballabh Pant, Union Minister for Home Affairs.

Members

Shri V. T. Krishnamachari, Deputy Chairman, Planning Commission.

Shri Morarji Desai, Union Minister for Finance.

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Shri K. C. Reddy, Union Minister for Works, Housing & Supply.

Shri N. Sanjiva Reddy, Chief Minister, Andhra.

Dr. B. C. Roy, Chief Minister, West Bengal.

Secretary

Shri Indarjit Singh, Joint Secretary (Economy), Union Ministry of Finance.

Composition of the Team for Selected Buildings Projects.

Leader

Shri S. K. Patil, Minister for Transport and Communications.

Members

Shri Sarup Singh, ISE (Retd), formerly Director, National Buildings Organization.

Dr. Eng. A. Carbone, M. I. A. B. S. E., Consulting Engineer, Calcutta.

Shri C. P. Malik, Director, National Buildings Organisation *(ex-officio)*

Secretary

Shri T. S. Vedagiri, Superintending Engineer.

General H. Williams, Director, Central Building Research Institute, Roorkee, has also kindly agreed to attend meetings of the Team and the Panels as and when he can spare time. He has, however, placed the facilities of the Central Buildings Research Institute at the disposal of the Team.

Minister of
Transport and Communications,
INDIA
New Delhi, December 10, 1958

My dear Pantji,

I have great pleasure in forwarding the report of the Selected Buildings Projects Team on Multistoreyed Buildings. You will recall that this was one of the items of construction taken up by the Team for study. A Panel of Engineers and Architects was set up for the purpose under the Chairmanship of Sardar Sarup Singh, ISE (Retd), Member--Chief Engineer of the Team. The Panel studied in detail some of the multistoreyed buildings which have been recently constructed both by the Central and State Governments in Delhi, Chandigarh, Calcutta, Bombay and Madras.

2. On the basis of this study, the report has been compiled. The Team is glad to endorse the views of the Panel and is grateful to them for the trouble they have taken in preparing this report.

3. A glance at plate appended at the end of the report will give an idea of the wide variation in cost both of the structures as a whole and of the components of multistoreyed construction undertaken in different parts of the country. The necessity, therefore, for fixing certain norms for planning and design is quite apparent, and this has been done by the Panel.

One of the important recommendations is regarding space utilisation within a building. The Panel has laid down that the proportion of carpet area to the total built up area should be at least 65% to 75%.

In other sections of the report, the Panel has dealt with, in detail, the procedure of design, choice of materials, site, management etc. Some of the administrative and financial aspects of the projects studied have also been dealt with.

4. With the recommendations given by the Team regarding space utilisation, design standards and site management, I am confident that Government will be able to get greater value for the money to be spent on multistoreyed construction in this Plan as well as in future plans.

5. I take this opportunity of thanking the various Central and State Government authorities for their co-operation in supplying the information required by the Team and for the facilities that they have accorded for on the spot studies and discussions.

Yours sincerely,
S. K. Patil.

Shri Govind Ballabh Pant,
Chairman, Committee on Plan Projects &
Minister for Home Affairs,
New Delhi.

REPORT ON MULTISTOREYED BUILDINGS

CONTENTS

INTRODUCTION

0.1 In the outlay of the Second Five Year Plan, the estimate of expenditure on buildings of various types, provided either directly under building projects or as a part of large schemes like Irrigation and Power Development or Steel Production Projects, totals up to a thousand crores of rupees—a very substantial portion out of a total outlay of Rs. 4800 crores. The buildings comprise storage godowns, multistoreyed and factory buildings, slum clearance schemes and housing estates.

0.2 In metropolitan cities, density of population has risen to very high figures. Land is especially scarce in the industrial areas. Obviously the only practical solution in such cases is vertical expansion, in spite of the difficulties that such type of construction creates in its wake.

0.3 Considerable amounts of money have already been spent on the construction of multistoreyed buildings both by the Centre and the States. A study of some multistoreyed office buildings recently constructed in New Delhi, Bombay, Calcutta, Madras and Chandigarh shows a marked degree of variation in cost, space utilisation, structural design and other important details. A stage has been reached in all big cities in India when multistoreyed construction is to be the order of the day. It is therefore very desirable, in the interest of economy of funds as well as of scarce building materials, to carry out a rational study of the multistorey construction technique, with a view to laying down guiding principles for the future.

0.4 The character of the technical and administrative machinery, that brings into being the engineering structures, cannot be divorced from the purely technical considerations; for what may be gained in an able design may be lost in inefficient execution.

0.5 There is a general complaint that the time allowed for technical planning is insufficient. This naturally makes methodical preparation of tender documents and appointment of qualified construction agency rather difficult. It is also generally contended that the existing governmental procedure is viscid, often leading to delays.

0.6 A detailed study of certain typical works, from conception to completion, is, therefore, necessary, in order to see the stages through which a

project has to pass and the avoidable delays that occur, so that remedies may be found out where possible.

0.7 The function of the Committee on Plan Projects is "to help in the efficient and economic implementation of the projects included in the Plan". A Team for Selected Buildings Projects has been set up for this purpose. This Team in turn has appointed a Panel for multistoreyed office buildings, comprising:—

1. Sardar Sarup Singh, ISE (Retd),	Member-Chief Engineer, B. P. Team	Chairman
2. Shri C. M. Master	Architect, Bombay.	Member.
3. Shri R. R. Sarma	Architect, Madras.	Member.
4. Col. H. C. Vijh	Formerely Dy. Director (Designs) E-in-C's Branch, Army Hd. Qtrs. Now Chief Engineer, Balmer Lawrie & Co. Ltd. Calcutta.	Member
5. Shri M. S. Bhatia	Housing Advisor, Ministry of W. H. & S.	Member
6. Shri K. Rama Varman	Superintending Engineer C.P.W.D.	Member
7. Shri T. S. Vedagiri	Superintending Engineer B. P. Team	Member-Secretary

0.8 The Team for Selected Buildings Projects chose the following buildings for evaluation:—

(1) Queen Victoria Road Building, New Delhi.
(2) King Edward Road Building, New Delhi.
(3) A. G.'s office, Madras.
(4) Income-tax Building, Bombay.
(5) Sachivalaya, Bombay.
(6) Telephone Bhavan, Calcutta.
(7) West Bengal Secretariat, Calcutta.
(8) Secretariat Building, Chandigarh.

0.9 The Panel held its preliminary meeting at Delhi on the 12th June 1957 to lay down the procedure for its work and held ten subsequent meetings at different places. The details of these meetings, the persons with whom the Panel had discussions and the buildings visited are given in Appendix I.

0.10 Work files pertaining to the various buildings, giving the factual data regarding administrative and technical sanctions, engagement of contractors, progress of work and expenditure and final settlement of contractor's account etc. were also examined in detail and reports prepared by the staff. These were considered by the Panel at its various meetings and form the asis of their appraisal of the existing administrative system. The information collected is given in Appendix II. Appendix III gives important technical data about the various buildings evaluated by the Panel. On the assessment so made on the technical as well as administrative side of the project, the Team made critical reviews with regard to each building and forwarded them to the Chief Engineers concerned for their comments. On the receipt of replies from Chief Engineers, the Team recast the reviews in the light of replies received. The final reviews of the various buildings taken up for evaluation are given in Appendix IV.

0.11 The subject of multistoreyed buildings covers a vast field of Civil Enginnering. Consideration of administrative and financial procedure also cannot be ignored. This report obviously cannot cover the entire field. It has, therefore, been confined to important issues that are relevent to the immediate objective of the Committee on Plan Projects, viz. to exercise a measure of check that will result in better utilisation of funds and materials at the disposal of the country and in elimination of delays.

0.12 The report has been divided into four sections. The first section deals with siting, orientation, space utilisation and amenities. The second section is devoted to structural design and building materials. The third section deals with planning, programming, site management, etc., and the final section deals with financial, administrative and general matters. The report closes with a summary of recommendations.

0.13 Our thanks are due to the various departments and individuals who have supplied the information required by the Panel and given valuable suggestions. We are also thankful to the National Buildings Organisation who have helped in processing the technical data received from several agencies. Acknowledgement is also due to various technical publications, material from which has been utilised in the compilation of this report.

SITING, ORIENTATION, SPACE UTILISATION AND GENERAL PLANNING

1.1 *Siting and Orientation :* The design of a building starts with the preliminary study of site, its shape and relative position of access roads, development problems, parking facilities, etc. It is very desirable to orient a building so as to avoid exposure of the occupied rooms to Eastern and Western sun, as otherwise expensive measures may be necessary for screening the penetrating sunlight, especially from the West.

1.2 From the analysis of the data relating to multistoreyed buildings examined by the Panel, it has been observed that the percentage of lettable space or carpet area (i.e. total floor area minus sanitary accommodation and circulation space for lifts, staircases, corridors and entrance halls) varies from 56 to 67. We have in this report given a number of suggestions for better utilisation of space and we consider that on the basis of those suggestions it should be possible to achieve a percentage ratio of 65 to 75 for framed structures; and the Architects and Engineers should make it an aim to achieve this figure. Of course, in case of load bearing structures, this proportion will be somewhat less.

1.3 *Space requirements :* The planning of space depends upon the users' requirements. It is generally observed that the majority of people seldom know what exactly they want in a building until they see the building in a completed shape. It is also difficult for non-technical people to visualize even the simplest grouping of architectural spaces, their functions, adequacy and their cost. At the same time, it is equally difficult for the planners to visualize the needs of the users unless they are stated in a precise manner. However, it is for the architect to study the requirements of the user with patience and convince him as to what he should have and correlate it with available finances.

1.3.2 In respect of government multistoreyed buildings, it should be possible to ascertain the space requirements, with a good measure of accuracy, at the very planning stage, since the Ministry of Works, Housing and Supply have already fixed scales of accommodation for officers and staff of various grades.

1.3.3 For best utilisation of space, the scale and sizes of furniture should be standardised for all Government offices. Furniture layout for each room should be prepared at the planning stage.

1.3.4 Some amount of economy in space can be effected by providing built-in almirahs and cupboards for storage of records. Placing of almirahs and racks in corridors, apart from presenting an untidy appearance, reduces the passage space resulting in great inconvenience, and as such, this should not be permitted.

1.3.5 For clerical staff, from the point of view of economy, the rooms should be as large as possible so that cost of partition walls could be kept to the barest minimum. Large rooms of 5 bays length should have at least two doors, so that the room could be evacuated in case of fire. There should be, generally, one door for 20 members of staff occupying the room.

1.4 *Storage of Records :* Any space available in the basement which is surplus to the other requirements for which basement has been provided can appropriately be used for storage of records. Otherwise, record rooms should be located in the ground floor or in separate blocks. Another appropriate method is to plan an entire separate vertical section of the building for storage of records; this would necessitate short staircases for access to the record room floors which come at levels different from the floors of the main building. In the record rooms it is possible to manage with less day-light and lower ceilings. But the floors of such rooms have to be designed for heavier loading. A ceiling height of 8' is suitable for these rooms as it gives easy access to the top shelf without the use of a ladder. It is, of course, necessary that the record rooms or blocks should be provided with adequate fire escapes in case they cover more than two storeys.

1.5 *Committee Rooms* : An area of about 500 sft. is considered adequate for committee rooms required to serve an office with a carpet area of approximately 1 lakh sft. Provision above this figure would need to be specially justified.

1.6 *Rooms intended for occasional use :* In any building when rooms are to be provided for use on some special occasions, such as examination rooms, special care should be taken to see that the area of such rooms is kept to the barest minimum and as far as possible rooms of this nature should be planned for multi-purpose use, so that best possible use could be made of all the space provided in the building.

1.7 *Canteens & Allied Services :* It has been observed that the provision for canteens made in several buildings does not follow any rational lines. Conditions vary from place to place, depending upon social habits and the availability of suitable catering facilities nearby. Therefore, each

case should be examined on its merits. The layout should be made flexible for future expansion or contraction. If otherwise convenient, canteen should be located on top of garages and cycle blocks. If the canteen has unavoidably to be combined with the main building, for convenience, it should be placed in the middle floor. But, hygienically, the best arrangement is to place it on the top floor with a separate access for the canteen staff.

1.8 *Sanitary Units :* From hygienic considerations, it is best to site the water closet units along the external walls of a building. Should this not be possible, they can be placed in the interior of a building next to a shaft opening of adequate size, which is required in any case for lighting and ventilation. The soil and rain water pipes can be carried through the shaft.

1.8.2 Lavatory units comprise a certain number of W.C's, urinals and wash-hand basins. There should be a sensible sequence in their positioning. The wash-hand basin should be within immediate access from the entrance of the lavatory, urinals coming next and lastly the W.C's. It is also convenient if the urinals and W.C's face each other, and the wash-hand basins are located in the fore-ground area. The lavatory doors should be self-closing. The W.C. blocks should be rationally distributed over the whole area. The Ministers' and Secretaries' rooms may have attached lavatories; for other rooms, lavatories should be so placed that they provide easy access from a group of rooms. These observations may sound elementary, but their non-observance was conspicuous in quite a number of the buildings visited by the panel. Sometimes even the positioning of the entrance door was unsatisfactory from the point of view of privacy.

1.8.3 In the past no rational scale for the sanitary fixture has been followed. The Indian Standards Institution have, however, recently drafted their standards based on the population in a building which can with fair accuracy be estimated at one person per 70 sft. of carpet area.

1.8.4 Some extra provision of lavatory units is necessary for the visiting public. This should be near the entrance hall or the waiting room.

1.8.5 Stall urinals are expensive, and their use may be limited to areas intended for the visitors near the entrance hall.

1.8.6 During inspections we observed that in certain buildings the floor of the sanitary block, where lipped urinals had been provided, was not clean. It is suggested that a raised platform of glazed tiles properly sloped towards the drain below the urinals should be provided in such cases.

1.8.7 Niches should be provided for placing purses, handbags, etc. in each lavatory near the wash-hand basins.

1.8.8 The Panel observed that no arrangements for drinking water had been made in most of the buildings. In a few cases where this amenity was provided, the arrangement was far from satisfactory. This matter should receive consideration at the planning stage. The arrangement may take the form of fountains or water coolers placed in specially constructed niches at suitable places in the corridors, or, alternatively, a system of running cold water may be adopted.

1.8.9 *Janitor's room :* Space should be provided in each floor for placing brooms, pails and other equipment required for cleaning the lavatories and floors. A sink for washing inkpots should also be provided in this room.

1.8.10 An essential amenity which had not been provided in most of the buildings visited was a first-aid room. In large office buildings this is desirable.

1.9 *Other Requirements:* The space required for housing of air-conditioning plant, electric sub-station, telephone equipment, waste paper stores, post offiice and pumping rooms should preferably be provided in the basement. Requirements of all special services should be carefully worked out by the designer, after consulting the specialists, at the planning stage. Space required for the caretaker should be provided in the building. It is a good time saving device to provide a vertical chute, opening in the entrance hall, for the posting of letters from all floors to enable the postman to clear all the letters from the ground floor. Similarly, convenient arrangements near the entrance hall may be provided for delivery of post. Chutes should also be provided for the disposal of refuse, from upper storeys.

1.10 *Entrance Hall :* The size of the entrance hall should be adequate to cope with the peak traffic and should be commensurate with the importance of the building. The architect can very well use his skill here in creating a sense of dignity of space while still maintaining simplicity. It should normally not be necessary to make the entrance hall higher than two floor heights. The hall should be so planned that it is intimately grouped with the main stair-case and lifts without obstructing circulation. Space for enquiry, reception, public telephones and lavatories should be provided near the entrance.

1.11 *Space requirement for circulation :* We consider that a corridor width of 8' (2.44 metres) is quite adequate to meet all normal office

requirements. The continuity of long corridors should be broken and the monotony relieved by opening them out at about 100′ intervals by skilful architectural detailing. A well-designed corridor provides not only access to the rooms but also houses the air-conditioning ducts and services, whose positioning and dimensions have to be determined at the planning stage to ensure economical lay out.

1.12 *Garages :* In some of the buildings garages have been placed either in the basement or in the ground floor. As the spacing of columns and the sizes of bays are planned for the office accommodation on the upper floors, the garage size becomes wasteful specially on account of excessive depth. Moreover, due to specialised construction, cost of the multi-storeyed buildings per unit area far exceeds the construction cost of normal garage blocks. Therefore, it is economical to construct independent light structures for garages and cycle sheds provided sufficient land is available.

1.13 *Cycle sheds :* Covered area should be provided for cycles and the structure may be combined with the garages if convenient and economical. The user Department should conduct the necessary surveys of its requirements and intimate the number of cycles to be housed, along with the office space requirements.

1.14 *Height of floors :* A height of 11′ (3.35 metres) from floor to floor is considered adequate. Allowing for the head room required for air-conditioning ducts, it can give a minimum of 8′ clear ceiling height (from top of floor to bottom of sub-ceiling) in the corridors, which will be flush with the top of the fan lights above the doors.

1.15 The normal height of basement should be 8′ from floor level to the bottom of roof slab. Should service installations need a greater height, it should be arranged by depressing the floor or increasing the floor height locally, instead of increasing the height of the whole basement floor.

1.16 *Stairs and stairs-cases :* The sizes and numbers of the stairs are usually determined from considerations of fire safety of occupants. The number and location of stairs may also be considered in terms of travel distances. For office buildings travel distance should not exceed 150′ of which not more than 100′ should be along the corridor. The travel distance is measured from the farthest point under consideration to the entrance to the nearest staircase.

1.16.2 In the solution of the circulation problem and determination of satisfactory lay out and width of staircases, the architect has to base

his judgement on experience. Experiments carried out in other countries on the rates of flow of persons through stairs of different width give a broad basis for rational approach to the problem. The rates of flow are usually specified in terms of unit width of 21 ins. or 53 cms. A recommended rate of discharge is 40 persons per unit width per minute. Some authorities assume that, in an emergency, the entire floor in a building should be evacuated to the top of the staircase in a matter of 2½ minutes and the sizes and number of staircases should be such that the flow of occupants should be continuous from this stage. Staircases and exits should ordinarily be not less than 3'-6" or two units wide. When a limited number of persons not exceeding 75 in number, are served by a staircase, a width of 2'-6" may be specified. The method for determining the width of staircases should be based on a reasonably accurate conception of the flow of traffic which occurs when all the floors are discharging at the same time. The conditions during a fire should also be taken into account. Tables 1 and 2 below give the staircase widths in relation to number of persons to be served by two or three staircases in a building :—

TABLE 1

Two staircase buildings.

Minimum width of each staircase.

(Population distributed over all floors).

No. of storeys above ground floor.	Calculated number of people in building above ground floor.			
	Normal Risk		*Factories and Offices.*	
2	410	470	540	600
3	470	550	630	710
4	530	620	710	810
5	590	700	800	910
6	650	770	890	1010
7	710	850	980	1110
8	770	920	1070	1210
9	830	1000	1160	1320
10	890	1070	1240	1420
Minimumwidth of each staircase.	3'-6"	4'-0"	4'-6"	5'-0"

TABLE 2

Three staircase buildings—minimum width of each staircase.
(Population distributed over all floors)

No. of storeys above ground floor.	Calculated number of people in building above ground floor.			
	Normal Risk		Factories & Offices	
2	650	740	840	940
3	740	860	980	1100
4	830	970	1110	1260
5	930	1090	1250	1420
6	1020	1200	1390	1560
7	1120	1320	1530	1740
8	1210	1440	1670	1910
9	1310	1560	1810	2070
10	1400	1670	1950	2230
Minimum width of each staircase.	3′–6″	4′–0″	4′–6″	5′–0″

When the width of the staircase exceeds 3 units or 6′, a central hand rail is necessary for its best functioning.

1.17 *Size and Positioning of doors:* The size of the single leaf doors, without the fan light, should be 3′—4″ × 7′—0″. Where greater width is required, double leaf doors of size 4′—0″ × 7′ or 4′—4″ × 7′ may be provided. The doors for stores and W.C's should be 3′ × 7′ and 2′—8″ × 7′—0″ respectively. With fan light, the overall height should be 8′, ie., a 6′—8″ door and 1′—4″ fan light.

1.18 The placing of a door towards one end of a bay instead of in its centre has definite advantages in respect of space utilisation. In view of the scarcity of teak wood and its rising prices, it may be advantageous to specify flush doors for office buildings where superior finish is required.

1.19 *Lifts:*—Necessary information regarding the sizes of lift wells and the details for installation of the structural elements, etc., should be obtained from the manufacturer in advance of planning; otherwise, one may be faced with subsequent dismantling or difficult construction in inaccessible places. Doors of lift wells should be of the solid plate type so that the well may be effectively sealed in case of fire, otherwise it will act as chimney helping the spreading of fire.

1.19.2 During peak hours, the lifts may only be used in alternate floors—2nd, 4th, 6th and so on. This will save time in clearance and

avoid congestion. Persons travelling to and from the intermediate floors can use the staircases for one floor height. This procedure has been adopted with success in some of the buildings visited by the Panel. The lift installations should be capable of transporting the whole population of the second and higher floors in 20 to 45 minutes. Should economic stringency make it necessary, half the total number of lifts required ultimately may be provided initially; the rest being installed at a future date when funds permit.

1.20 *Airconditoning:* The specifications in respect of window areas, floor heights, ventilation, types of doors and windows, thermal insulation of roof and walls, sun shading etc. of buildings to be airconditioned are widely different from those of the buildings that are not intended to be airconditioned. It is, therefore, essential to decide the question of airconditioning at the planning stage. Subsequent alterations are costly and cause inconvenience. Glass areas of an airconditioned building should be reduced to the minimum and should be provided with louvres or other shading devices.

1.21 *Natural Lighting*: Good day-lighting is appreciated by people working in an office. All office rooms, as far as possible, should have, during a greater portion of the day, sufficient natural light to avoid artificial lighting. Certain foreign codes for cold climates specify a sky factor (i. e. the proportion of the area of the sky visible from the point of reference in relation to the maximum area visible in the open space) of 1% at a point not less than 12′ inward from the exterior wall and at a working height of 2′9″. A higher factor up to 5% is usually specified for drawing offices. The limitation on room size to obtain 1% sky factor, however, proves to be uneconomical. It has therefore, to be accepted that an inner zone, where the natural day-lighting falls short of the standard, is usually unavoidable, and has to be supplemented by artificial lighting.

1.22 Natural lighting in the corridors has been improved in some buildings by resorting to glazing above the door level to attract light from the flanking rooms. This is, however, an expensive arrangement. Besides, it makes it impossible to place the ducts under the corridor slab. Another method of improving day-lighting in the corridor is to construct some of the side walls in translusсent glass tiles. These are, again, very expensive, and should only be adopted in special cases.

1.22.2 One of the nice ways of having good lighting effect is by installing indirect lighting in specially designed set backs in corridors. The figures given in Table 3 can be taken as a rough guide for fixing of standards of illumination in different parts of an office building.

TABLE 3.

Table showing intensity of lighting In various parts of office building.

	Rooms	Intensity of lighting
I	Drawing offices	30—50 Lumens
II	Book-keeping, typing computing machines, filing and general office work.	20 „
III	Officers's room	15 „
IV	Conference and board rooms	10 „
V	Enquiry and reception	6 „
VI	Lavatories and wash rooms	5 „
VII	Corridors and stairs	3 „

1.23 The functions of the windows are to permit natural lighting and ventilation. The ceiling height, the extent to which the surrounding areas are built up and the depth of the room in conjunction with a desired sky factor will determine the glazing area and its height from the floor.

1.24 It will be useful if the National Buildings Organisation would conduct surveys in the office buildings in various places in the country to determine the actual lighting in relation to glazed area and the sky factor. This will provide a rational guide for specifying depths of the rooms, window area and heights in various climatic regions of the country, from the point of view of lighting.

1.25 Rooms facing West should have blinds to keep out the oppressive afternoon sun. Louvres and vertical fins are other solutions, but these become expensive if they are to be aesthetically pleasing and durable. Materials suitable for louvres are aluminium or stainless steel. It has been reported that venetians with aluminium finish reduce solar heat by as much as 75%. Double glazing of windows reduces sensible heat by 50% and solar heat by about 10%. A scientific study of the effect of shading window openings with louvres of various shapes and materials would be interesting. Experimants should be undertaken by the C. B. R. I.

1.26 A good solution to the problem of shading the windows appears to be the traditional venetian shutters of the vertically-hung or the sliding type, as was observed in one of the buildings in Bombay. For these to be successful, only seasoned timber should be used.

1.27 From the point of view of lighting, the windows should obviously be planned on the basis of the glass area required. Since

metal windows give a greater proportion of glass area than timber windows, they can be comparatively smaller in overall size. This fact is not generally appreciated and identical sizes of windows are often provided for both the types. For office buildings metal windows are preferable to wooden windows.

1.28 *Sound Insulation:* The aim of sound insulation is to exclude all external noises and reduce transmission of sound created in the building itself. In most office buildings visited, the external traffic noise was not found to be very disturbing even though they were in closely built up urban areas. The weakest point in the defence against external noise is a window in the exterior wall and the insulation of sound through the window is linked with its functions as a ventilator. Where windows are required for ventilation, the sound insulation value of the windows is obviously vitiated. For comfortable working in the office the level of the 'background' noise should not be more than 35-40 phons.* Noises are of two types-structure borne and air borne. Indoor noises of the first category are usually caused by banging of doors, foot-steps, furniture movement, typewriters and computing machines, etc. A floor with soft coverings considerably damps all impact noises on the floor. It will be advantageous to plan the layout of rooms so as to segregate areas creating machine noises, like typing-pool, mechanical computing rooms, etc. Partition walls, separating the rooms from which such noises emanate, should have a sound reduction value of the order of 40 decibels,* which is obtainable with most specifications now in use.

Cracks in partitions reduce their sound insulation value considerably. Sound also passes round and across the edge of partitions, unless they are of discontinuous construction. To reduce noise from closing of doors, etc., felt strips or rubber paddings are advocated, or door closers may be used. These are very desirable in the case of doors of Committee Rooms. Air-borne noises are relatively less disturbing.

1.30 *Thermal Insulation :* Thermal insulation of roofs and reduction of heat penetration through walls and windows are of special importance to air-conditioned buildings. Various specifications used for roof covering are given in *Appendix V.* Alternatives are the use of materials like thermocole, thermolitecrete, etc. It will be a good thing if these were

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* **'Phons & Decibels'**

"There are two units of noise measurement, the phon and the decibel, both of which are required to state the results of measurement, but both of which, for the purposes of the layman, can often be considered almost as equivalents over a fairly wide range of frequencies.

investigated and evaluated by the C. B. R. I. Large inflow of heat occurs through doors and windows. Elaborate provisions for thermal insulation of walls and roof loses significance, at least in part, when windows and doors are not designed to eliminate or at least minimise these leakages.

1.31 Where the roof is covered with an asphaltic material for water proofing it is preferable to give it a reflecting surface both from the point of view of reducing air-conditioning load and increasing its life. Such treatment includes the use of light coloured lime stone or gravel as blinding material. A simple treatment requiring annual renewal is just white-washing or painting. This, however, does not enhance the durabili y of the roof covering. Suitable specifications have been suggested in the N.B.O's Technical Information Series on Thermal Movements in buildings. Further research in this direction seems to be necessary.

STRUCTURE AND MATERIALS

2.1 The structural design of a multistoreyed office building is circumscribed by many considerations, strength and stability, moisture penetration and condensation, thermal and sound insulation, fire hazards, durability and maintenance. Some of these requirements work in opposing directions. The designer has to use his discretion in striking a balance with a view to reducing the cost of construction to the minimum and at the same time avoiding excessive maintenance cost.

2.2 In general, the cost of construction can be reduced by paying careful attention to functional requirements rather than following the dimensional specifications for the elements constituting the buildings. Recourse to modern practice of welding the steel elements instead of rivetting, adoption of prestressed reinforced concrete and pre-fabrication, use of light-weight materials and mechanisation can all contribute to economy. Each case has, however, to be dealt with on its merits, depending upon available local materials and facility of adoption of new techniques. Use of new materials and economic methods of construction are not receiving the attention they deserve.

2.3 *Super-imposed Loads :* Compared to the dead load, the super-imposed loads in office buildings are usually light. The latter are at present governed by the Indian Standards 875 and 456. Execution of a Sample Survey of the actual super-imposed loads in office buildings is at present engaging the attention of I.S.I. and the N.B.O. In office buildings where the officers' rooms are specifically reserved and are not likely to be used as general office rooms or as stores, it may be argued that there is justification for adopting reduced live loads for such parts of the floor. Such cases, however, require very careful consideration. Occupancy may change and the limitation in superimposed loads, even when prominently exhibited, may not be understood or respected by users. In view of this, we do not consider the distinction between officers' and office rooms as practical.

2.4 *Dead Load :* The main elements contributing to the dead load are the columns, beams, floor slabs and filler walls, both external and internal. It should obviously be the aim of the designer to reduce the weight of these elements to the minimum. Reduction in the weight of walls and slabs reduces the size of the columns and this has further effect of reducing the self load of the columns, resulting in further reduction in their sizes. The effect is geometric.

2.5 *Filler Walls :* The first step in the reduction of the permanent load is to keep down the weight of the filler walls. At present the general practice is to adopt 13½" external walls on grounds of waterproofness and thermal insulation. A 9" brick wall, properly rendered on the outside, can serve as an effective moisture barrier, except in areas subject to torrential rainfall. Both from the point of view of moisture and thermal insulation, a superior method is the 11" cavity wall (2 leaves of 4½" with a cavity of 2"). The Post-War Building Studies of England have admirably described the principle upon which the cavity wall depends for exclusion of water. A quotation from them in extenso is considered worthwhile.

2.5.2 "In practice, cavity may have to be broken at such points as lintels, sills and jambs, and by the use of wall ties. Careful design of detail at those points and careful workmanship are needed if moisture penetration is to be avoided."

2.5.3 "Whether the cavity should be ventilated or not, has frequently been a matter for discussion. The chief argument in favour of ventilation is that a good current of air in the cavity keeps the internal leaf of the wall dry and so prevents the decay of timber built into the wall. A fair criticism of this claim is that with proper constructional details the inside leaf should not get so wet as to give rise to internal dampness and that timbers built into the wall should therefore never reach the 20% moisture content necessary to permit the growth of wood-destroying fungi."

2.5.4 "The advantage of sealing a cavity is definite; the heat loss through an unventilated cavity wall is less than through one that is fully ventilated".

2.5.5 "A comparison of the heat transmittance coefficients (U= B.Th.U per sft. per hr. for 10F. difference of air temperature) for ventilated and unventilated 11" cavity walls is made in the following table."

Wall	South Exposure severe	North exposure severe	N. E. & N. W. Exposure normal
11 in. cavity wall, plastered, unventilated.	.29	.31	.30
11 in. cavity wall, plastered, ventilated.	.33	.36	.34

2.5.6 "The lower heat loss through the unventilated wall on the cold side of the house might well be sufficient to obviate condensation of which there is a serious risk with a ventilated wall."

2.5.7 "When cavity walls are built as panels in framed multistoreyed buildings, the stability of the walling is to some extent dependent on the number of ties between the two skins and on the fixing of the window frames. This problem of stability of the walling is statically indeterminate especially where windows occur. Experience has shown that cavity walls in panel 14 ft. square built of two 4½ in. skins of brickwork, or of an outer skin of 4½ in. brick and an inner skin of hollow clay blocks, or solid partition blocks, have proved satisfactory in conditions of normal exposure."

2.5.8 "Cavity walls are reliable for the exclusion of weather if they are carefully designed and built. Failure to resist damp can usually be traced to bad detailing at parapets, sills, heads and jambs of openings, and at damp courses; or to careless workmanship generally, and in neglecting to keep the cavity clear and the ties free from mortar droppings. Precautions taken to prevent the passage of water from the outer to the inner skin should include the following :—

(a) The use of wall ties which will either trap or throw off the water,

(b) The provision of open vertical joints to allow the escape of water at joints where it is likely to collect as it does over openings.

(c) The prevention of mortar droppings from entering the cavity during construction by means of a movable board or sacking, and the cleaning out of the foot of the cavity on completion through openings which have been left and filled temporarily with bricks in sand.

(d) Carrying the cavity down to at least two courses below the damp course, so as to provide a space into which any mortar droppings which have escaped notice during building, or fall after completion, can collect without forming a bridge across the cavity above damp course.

(e) The provision of damp courses over openings.

(f) The provision for vertical damp courses or cavities at the jambs of openings."

2.5.9 "In order to keep the cavity free from mortar droppings the accepted standard of 2 in. must be regarded as a minimum. Considerations which favour a somewhat wide space are that, if it were increased,

the jambs, in which a vertical course of slates in gauged mortar is provided as a damp course, could be constructed with purpose-made three-quarter bricks. The extra width would facilitate cleaning out the cavity during construction."

2.5.10 Some forms of construction other than those normally used are :—

(a) 5" pumice concrete, rendered externally and plastered internally.
(b) 9" foamed slag concrete —do—
(c) 10" clinker concrete —do—
(d) 12" no-fines concrete —do—

or combinations of structural materials, incorporating an air-space, such as :

4½" brickwork, 2½" air-space and 4" pumice concrete plastered internally.
" " 7" foamed slag " "
" " 8" clinker " "
" " 6" hollow clay block " "
" " 3" diatomaceous earth block plastered.
9" brickwork " 3" pumice concrete
" " 5" foamed slag
" " 4" hollow clay block.
4" hollow clay block rendered, 2" air space, 3" clinker concrete slab, plastered internally.

(a) above is not practical, as pumice stone is not economically available. (b), (c) and (d) would certainly be more expensive than a 9" wall, but they need development in the country. Similarly, these methods in combination with foamed slag, clinker, etc., need development.

2.5.11 The 9" brick wall with 4" hollow clay block should prove useful and suitable, although it would be somewhat expensive. By and large, the 11" cavity wall appears to be the best proposition.

2.5.12 Internal walls are seldom exposed to conditions that call for special attention to insulation. They should, however, be designed so that their surfaces provide similar response to the internal heating conditions as the inner surfaces of the external walls of the same room. The thermal transmittance value of an internal wall may be important where the wall separates a South-facing or heated room from a North-facing or unheated room. The normal practice in India is to adopt 4½" brick walls for non-load-bearing partition walls. It is economical but it cannot be described as a light weight construction. The adoption of perforated bricks or tiles will reduce their load by about 33%. The cost of the

partition in this case may be more but this will be offset by the saving in frame work and foundations. Where walls have to carry fixtures, solid construction is desirable or self-supporting type of fixture may be adopted.

2.6 The next step in the design of a building is the structural arrangement to be adopted. This depends upon the use to which the building is to be put. It may be framed or semi-framed or may be of fully load bearing type. Ordinarily, a building of more than 4 floors height may, with advantage, consist of framed construction and, upto a 10 to 12 floors height building, reinforced concrete construction is more economical than structural steel.

2.7 The belief that, up to four floors, load bearing wall construction is cheaper is not always borne out by facts. It should, therefore, be examined early in the planning stage whether any economy in ultimate cost in terms of useful carpet area is obtainable by the adoption of load bearing wall construction. It may, however, be mentioned that, in the present context of shortage of steel regardless of the economy in cost, a bearing wall construction may be preferable. The steel position may often be the deciding factor in the selection of the type of building to be adopted.

2.8 In the case of framed buildings, the most important aspect of structural planning is the arrangement of the columns and beams. The sizes of columns, beams and slabs depend upon the spacing and arrangement of the frame. Economic spacing for the columns has to be worked out. This is dependent upon the architectural and space requirements. Modern tendency in ordinary buildings is to set out the frames in regular grids. This may be rectangular or nearly square in plan. It is generally observed that in the case of framed construction, arrangements of columns and beams with a central corridor, and a spacing of about 12′, is economical. This can be obtained by a variety of frame arrangements. The spans suitable to office buildings are 14′ to 16′ and 25′ to 30′ on either side of a central corridor. This again can be obtained by different frame arrangements. There can be four rows of columns, each row separating a span, or alternately, there can be three rows of columns with one of the corridor walls running independently of the columns.

2.9 For buildings with heavy loading, a square grid of 20′ to 25′ is often economical with flat slab construction. The running of services becomes convenient. For a very tall building, viz. above 15 storeys height, it is better to adopt a rectangular pattern in plan for good lighting and ventilation effect. For the grid recommended above, the block width would be about 50′ to 60′. This, in any case, is the maximum that can be adopted.

2.9.2 For keeping the resultant of the vertical and horizontal loads, including wind load, safely within the columns, it is better to concentrate the entire loading on a small number of big columns rather than distribute the load over a large number of small columns. The limitation, however, will be the foundation conditions which should be carefully determined and evaluated.

2.9.3 The air-conditioning ducts require appreciable head-room. With limitation in ceilings height, it is not possible to have deep beams running across the corridor if the ducts are to be installed there. This difficulty may be overcome by designing the outer frames as two independent portals connected by the R.C.C. slabs of the corridors. An alternative arrangement which is gaining currency is to have uni-directional frames. This is particularly suitable with hollow slab construction or with the use of hollow concrete blocks or hollow clay tiles. Examples of these types of construction were met with by the Panel during their visits. In a building in Bombay, it was observed that the service conduits and drain pipes had been accommodated in a 6″ solid layer of lean concrete, over the structural slab. This obviously is a very expensive method. It materially adds to the dead load of the structure, and increases the cost of the frame work and foundations. In another building in Delhi, the same facility was obtained by providing a hollow floor with hollow concrete filler blocks, the hollows accommodating the services. This arrangement keeps down the superimposed load.

2.10 The uni-directional frames can well be adopted for structures up to about eight storeys high. The wind load is taken care of by the floor slabs. For taller buildings, cross bracing either with solid R.C.C. walls or bracing girders is essential. Similar treatment may be necessary in seismic zones.

2.11 Another method of structural planning is "cantilever construction." In this arrangement, the outer columns are placed well within the building. The external walls are supported by beams cantilevered from the columns. The advantage is that the foundation work for columns can be carried out entirely within the site boundary without interfering with adjoining property. There is greater freedom in the positioning of the windows and the running of services round the perimeter of the building. Maximum advantage in this type of construction is obtainable with the use of light external walls, of sheeted materials or hollow clay tiles. Cantilever construction can also be adopted in conjunction with flat slab design.

2.12 In cases where large floor areas without any obstruction are required, the diagonal beam system may be adopted. In this arrangement, the beam depth is nearly half of what is otherwise required, and the criss-cross arrangement is pleasing.

2.13 In certain cases it may be necessary to avoid columns in some floors of a building which are to be used as assembly halls etc. In the normal run of design, this would necessitate long and deep beams in all the floors, and consequent decrease in the head-room and increase in the dead weight of the structure and heavy foundations. Recourse to Virendeel girder frame is one of the methods to overcome the difficulties. For general application, however, the method is not economical.

2.14 The slabs of office floors may consist of ordinary reinforced concrete or may be of 'T' beam construction with hollow clay tiles or hollow concrete blocks.

2.15 Modern approach to architectural and structural planning is guided by functional requirements of the elements constituting a building rather than by compliance with dimensional specifications which are usually laid down by the local bodies. For instance, the thickness of walls is governed by requirements of damp-proofing, moisture penetration, thermal insulation, sound proofing and stability. In other words, the demensions depend on the quality and performance of the materials employed in the construction of a structure. This approach enables a large variety of alternative materials to be used and in industrially advanced countries every opportunity is being taken to discover and manufacture new materials to meet functional requirements. Advance in India in this direction is very limited so far, but it is hoped that, with the efforts of the N.B.O., the gap would soon be filled up and designs in this country will also veer towards modern concepts. It is necessary that when a building is planned, a careful study should be made of the materials available for the various components of the building and their effect on the overall cost of construction. For example, a wall constructed of light-weight materials may be expensive in itself, but the overall economy as a result of reduction in the size of the columns and beams and foundations may justify its use. For good results, it is necessary that there should be close association between the architect, the engineer and the builder.

2.15.2 There is need for setting up of a few permanent centres at important places in the country in order to exhibit building materials and techniques of construction as developed in advanced countries. Such

centres exist in most advanced countries. We understand that such a centre is being planned in Delhi by the N.B.O. and that in due course similar centres will be set up in other parts of the country. It is a step in the right direction for the propagation of knowledge regarding developments in building materials, rational planning and economic construction.

2.16 The materials usually employed in framed structures are concrete and steel. The choice depends on spans, loading, degree of fire resistance required and availability of materials. Use of prestressed and prefabricated elements will considerably reduce the construction time. It will also reduce shuttering which is expensive specially in the upper floors.

2.16.2 Doubt exists in the minds of Engineers about the practicability of producing continuity in prefabricated elements used in a structure. During his lectures in India, Prof. Nervi, an Italian expert in reinforced concrete building construction, demonstrated that, by welding reinforcements and pouring rich concrete in the joints, complete continuity can be achieved. He gave example of a big hangar constructed by him with prefabricated elements before the World War II, joints of which remained intact even after suffering bombardment.

2.17 In many cases where steel frames have been adopted, the old practice of not taking any advantage of the concrete encasing the steel still continues. Modern codes in other countries permit additional strength in such cases. The Indian Standard Code for use of structural steel in buildings also permits additional strength which should be taken advantage of.

2.18 *Welding :* In advanced countries, welding instead of rivetting has become a standard practice in the erection of steel frames. It leads to rigid joints and substantial economy in steel. This combined with the application of the plastic theory in the design of the rigid frame structure, can achieve a very substantial saving in steel. The Indian Standards Institution has in hand preparation of code of practice and handbooks for welders.

2.18.2 Welding can be profitably adopted even in R.C.C. structures. At present there is a good deal of wastage of mild steel reinforcement due to overlapping of bars. If the bars are welded, this wastage can be avoided.

2.18.3 The Report of the Committee constituted by the National Buildings Organisation on Economy of Iron and Steel in Building Construction contains very useful recommendations which, we recommend, should be adopted by all designers.

2.19 At present a working stress of 16000 lbs. per sq. in. is being assumed for mild steel reinforcement as an appreciable part of the steel supply is of untested quality. It will be better if tested and untested varieties of steel are stored separately and used according to the designs. It may be possible to reserve tested steel for important projects like multi-storeyed buildings. If this is assured, there will be no difficulty in assuming higher stresses in steel and thereby achieve economy.

2.19.2 Some of the Departments have adopted a higher working stress for concrete. In one case, a working stress of 1000 pounds per sq. inch had been adopted. It may be pointed out that increase in the working stress of concrete alone cannot lead to economy unless the working stress in steel is also correspondingly increased.

2.19.3 Economy in R.C.C. frame-work also depends to some extent on the judicious choice of the concrete mix for the various components. The omnibus adoption of 1:2:4 mix for all components as had been done in most buildings observed by the Panel, is not conducive to economy. It is advantageous to use a mix of 1:1½:3 or even 1:1:2 for members which are predominently in compression. The normal 1:2:4 mix can be adopted for members subject to flexural stresses. It is, however, better to design the mix and use quality controlled concrete.

2.20 Before proceeding to the design of frame-work, a few points regarding slabs and beams designed for taking the load of partition walls may be mentioned. It is advisable to decide upon the location of partition walls fairly accurately in the initial stages and allow for the load in the design of beams that carry them. Partition walls that become necessary later can be of light weight materials. A design on this basis would lead to economy both in the foundations and frame-work. The practice of designing of beams for bearing the weight of partition walls results in increase in cost and, as far as possible, this should be avoided. In one case, the Panel observed that the entire floor system was designed to take up brick masonry partition at any place. Such a design would result in much additional cost and is considered to be not commendable.

2.21 Frame analysis is normally done according to the well-known method of moment distribution. Several variants of this are in use, but the basic principle is the same. As against this laborious method, the procedure sometimes adopted is to ignore the continuity of the structure and to design the beams as simply-supported and the columns for direct load only. This saves time in calculations, but the procedure is technically not correct. Ignoring the rigidity of the junctions of beams and columns will not induce them to work as free members.

2.21.2 Normally, frames are analysed in one plane only. But by three-dimensional analysis saving to the extent of 15% can be achieved. The calculations are, however, elaborate and lengthy. In the absence of a quick method of computation, such as the use of electronic brain, the effort is not considered worth while as the time taken for designing is disproportionately excessive. It is, however, recommended that one electronic brain should be obtained for all major cities like Delhi, Calcutta, Madras and Bombay, and installed in a central place for use by the various departments and also by private agencies on payment. Model analysis of a frame by photo-elastic methods needs special mention; this reduces the designing time.

2.22 In the case of steel structures, design of welded frames on the basis of plastic theory can be entrusted only to very specialist hands of whom there is paucity in the country. It is, therefore, suggested that, where steel structers are adopted, a clause should be provided in tenders that alternative designs on the basis of the plastic theory by firms employing qualified hands will also be considered. This will necessitate elaborate checking of all designs and time-consuming comparisons, but is obviously the best way of encouraging the evolution of economical designs and cheaper construction methods.

2.23 The ultimate load design is getting increasingly popular in some other countries. This method can be adopted for proportioning the members of a framed structure and is particularly advantageous in the case of compression members and doubly reinforced beams.

2.23.2 A high and consistent quality of concrete is necessary for work designed on the basis of the ultimate load theory. This should only be adopted if, at the design stage, it is decided to entrust the work to builders who can be depended upon to produce quality work. This will necessitate selective tendering.

2.24 *Expansion Joints:* Expansion joints in R.C.C. frames are normally necessary at intervals of 60 to 100 feet. The exact location of these requires careful consideration. A joint provided on the straight face of the building may be difficult to treat architecturally. It is essential that it should be so located that it is not conspicuous. Recesses and turns in buildings are the best places for providing joints. Joints can also be concealed behind some projections. This question must be settled at the planning stage. The problem of thermal moments in buildings has been discussed by the N.B.O. in their Technical Information Series.

2.25 *Quality Control of Concrete :* The Panel observed that poor quality concrete was being placed in some of the structures visited by them. There was no grading of aggregates nor any control over the water cement ratio. Examination of Slump Cones revealed that they had not been used for a long time, if ever.

2.25.2 It appeared to the Panel that, to allow for poor quality control, mixes richer in cement than necessary had been specified. With proper quality control this practice should not be necessary. We are of the view that in the case of multistoreyed buildings, where higher permissible stresses in columns and other members are adopted with a view to reducing their sizes, it should be the endeavour to design the mix to obtain the desired strength and to strictly enforce the specifications for mixing and placing of concrete. To obtain quality concrete, we again recommend the adoption of the system of limited tendering, whereby only such contractors who are competent of producing quality work are allowed to tender.

2.26 *Foundations*: In some cases the cost of foundations compared to the overall cost of the building was too high. There was no evidence in such cases of experts having been engaged before deciding upon the bearing capacity of the soil and the type of foundations to be adopted. Foundation engineering has now become a specialised study. It is our opinion that, where foundation exploration shows special features and where the structure is heavy, needing special foundation study, qualified foundation experts should be consulted. The data should be properly analysed and alternative foundation designs prepared in order to arrive at the most economical solution.

2.27 *Water-proofing of terraces :* We found a variety of specifications being adopted for the water proofing of terraces. Those are listed in Appendix V. Bitumen exposed to sun deteriorates and normal practice adopted to preserve it is to cover the same with stone chips, china mosaic or aluminium foil. As light coloured chips have higher coefficient of reflection, those should be used, when available, in preference to darker coloured chips.

2.27.2 We understand that water proofing of flat terraces is one of the problems that is at present engaging the attention of the N. B. O. and suggest that this should be given a high priority and suitable specifications for different conditions prevailing in the country may be brought out for the guidance of the builders.

2.28 *Variations in cost* : Examination of a fairly large number of

buildings has shown wide variations in the cost of foundation, framework, cladding, fenestration and finishing, as evident from the graph in Plate 1. This emphasises the necessity for more rational planning and design practices. We recommend that statistical data of the break-up of costs may be worked out for the buildings constructed by all major construction agencies and supplied to the National Buildings Organisation for consolidation and publication. This will enable designers and builders in various parts of the country to study current trends in designs of various components of buildings and compare results with their own achievements.

2.28.2 Shortage of cement and steel are major problems in India. Of late, there has been some improvement in the position of cement. But the shortage of steel is likely to continue till all the new steel plants start production. Even then, priority will have to be given to the Railway Projects and heavy industries. Continued efforts for the economy in steel are, therefore, essential.

2.28.3 In case of steel framed structures, large quantities of steel are required. At the same time, use of cement is not correspondingly reduced, as the steel sections have still to be encased in cement concrete. The adoption of steel structures should, therefore, be avoided as far as possible.

2.28.4 In case of R.C.C. structures also, consumption of cement and steel varies greatly in buildings of similar types. Substantial economy in cost and materials can be had by judicious choice of spans and spacings of frames and of filler materials that add to the permanent load.

2.28.5 Adoption of prestressed concrete results in saving in cement and steel. Its increased use can be fostered only by engaging firms who are in a position to give alternative schedules with specifications in competitive tendering. Some weightage in favour of designs conducive to saving of both steel and cement would not be unjustified.

2.29 *Finishes :* In most of the buildings visited by the Panel the practice for external finishing is to render the exterior with cement mortar. In some buildings pleasing appearance had been obtained by use of materials like Snowcem and Permacem in appropriate shades. In other buildings stone facing had been used with advantage. We are of the opinion that public buildings should present an aesthetically pleasing and dignified appearance. While we consider that limited stone facing adopted in certain buildings especially in Delhi adds to their beauty and grandeur, extensive use of stone facing for the entire building with Kotah

stone for decorative purpose, as had been done in one of the buildings in Bombay, cannot be justified. Internal finishes in most cases were acceptable, except in one case where elaborate teak wood panelling had been adopted in the corridors.

2.30 In case of floorings, a variety of specifications were found in use. Some of those are listed below :—

(1) Plain cement-concrete flooring
(2) Mosaic tile flooring of various shades
(3) Coloured cement tiles
(4) Grey cement tiles
(5) Kotah stone
(6) Marble to a limited extent in entrance halls, etc.

We are of the opinion that entrance halls, corridors, public rooms, canteens, etc., should have superior flooring, e.g. marble or mosaic depending upon the importance of the building. Sanitary blocks require floorings such as of glazed tiles or with oxy-chloride glaze, which can safely withstand periodical washing with acid. Ordinary cement concrete flooring was found in the corridors in one of the buildings visited by the Panel in Calcutta; this presented a drab appearance and was not in keeping with the class of the building.

PROGRAMMING AND PLANNING OF SITE OPERATIONS

3.1 *General* :—We observed during the inspection of various building sites that there was very little evidence of a rational programming of work. It also appeared that organisation of work at site, viz. methodical stacking of materials and disposal of surplus materials, etc. had not been thought of. Obvious economies had been neglected. No work has been carried out in this country on the impact of various factors of programming and site management on the ultimate economy in Building construction. We may, however, draw lesson from foreign experience on the significance of various points that go to make a good programme and a good site management, even though their quantitative evaluation may be difficult without specialised study. This part of the report is accordingly devoted to bringing out in general terms the advantages that accrue from a good programme and planning and the principles on which these should be carried out. The idea is to highlight the extent to which we are deficient in our construction operations.

3.2 As discussed earlier a better and more efficient utilisation of building materials and rationalisation of the shape and proportion of buildings and their components can bring about considerable economy; still better results are possible if the work itself is carried out according to a schedule and planned site management. In the case of industrial operations carried out in factories it is relatively easy to rationalise each operation but in the case of buildings it is difficult as each site has its special characteristics. Moreover, the operations at a building site are performed by several agencies and co-ordination of their activities is not always easy of attainment.

3.3 Builders are becoming increasingly conscious of the importance of efficient programming and site organisation. They realise that best results in productivity are only possible with systematic approach. An essential preliminary to good site organisation is the detailed programming of all operations before work commences. Preparation of programme automatically brings out the problems that will be encountered in its execution and it enables the builder to take measures to ensure supply of materials and labour at the appropriate time. It further creates understanding and confidence amongst the sub-contractors and others connected with allied services. Operations can then be phased correctly and

arranged in proper sequence and the work of various kinds can be so arranged that unproductive time both within and between the succeeding operations is minimised, reducing construction time and overheads.

3.4 The programme should :

(i) Show the quickest and the cheapest methods of carrying out work consistent with available resources of the builder ;

(ii) Ensure by proper phasing of operations with balanced gangs in all trades,continuous productive work for all the operatives employed and thus reduce unproductive time to the minimum.

(iii) Provide an assessment of productivity in all trades to permit establishment of equitable piece-work rates and bonus targets where necessary.

(iv) Determine dates and periods when each sub-contracting work can commence and end.

(v) Provide information on the quantities of materials and their essential delivery dates, the quantity and capacity of the plants and the periods during which they will be required on the site.

(vi) Provide at any time during the contract a simple and rapid method of measuring progress of work for information of the builder, the architect and the client; facilitating a rough valuation of work done upto any time.

3.5 Good results can be expected from correct programming only if work schedules and operations are properly prepared and adhered to. The main point to remember is that while making such schedules all working drawings to eight scale should be made available with all information necessary for completion of the buildings, right at the commencement of construction. This bas been emphasised elsewhere also but will bear repetition. Current practice observed in various building sites of sending labourers to site to start excavation at the time when final designs are no more than half done merely to satisfy the administrative departments who desire to see the work in progress, is wasteful in money and in time. It is the very negation of planning.

3.6 For purpose of preparation of schedule of work, the building site should be considered as an operational centre where transporting of materials, co-ordination of various building activities and these various activities themselves should proceed systematically and without hitch.

The organisation and work schedules should, therefore, be planned as are done for factory operations. If this is not done the organisation gets left to chance leading to hold-up and loss of output. To obtain best results the contractors, the architects and the engineers should work together as a team. Adequate time should be allowed for the contractor to make preliminary preparations and planning.

3.7 A few of the experienced contractors do pay some attention to site organisation but its importance as a rule is not realised in this country and the effect of site organisation on cost is not sufficiently and properly evaluated. A comparison of transport costs at various building sites gives a good indication of the extent to which any site organisation has been successful. Though no standards can be laid down for an efficient organisation of site, some rules for good practice may be suggested. Supply routes for materials should not cut across one another. They should be sufficiently wide to enable a moving vehicle to pass or overtake a stationary vechicle enroute. It is convenient to have vehicles travelling only in one direction at the building site. The supply line should run along the building but sufficiently away to leave sufficient but not excessive space required for stacking of materials and for movement of labour. Materials not in continuous demand may be stacked at relatively greater distances.

3.8 Builders, often under pressure for immediate start make costly mistakes like unloading materials in wrong places requiring longer transport lines and sometimes necessitating their shifting to more convenient locations later on. Excavated earth is sometimes heaped indiscriminately without proper consideration of its effect on the efficiency of movement and this often leads to double handling. It is important that it should be determined very early during the planning period how the excavated earth is to be disposed of. The position of spoil earth in relation to the site and the organisation of operations is important. The spoils should be immediatly deposited in their final locations to avoid double handling and the materials that are to be re-used at site should be stacked according to plan before construction starts.

3.8.2 Repetitive work by the same gang can substantially increase productivity. Division of work into cycles suitable for such treatment is, therefore, necessary at the time of programming of work. It may be argued that woking in cycles suitable for such a treatment can well involve greater building time than if all the operations were to proceed simultaneously; but with a well planned schedule the completion time will in most cases be satisfactory.

3.9 At the time the programme of work is drawn up, it should be possible to determine the type, the number and the capacities of the various types of equipment required for the job. Correlation of sizes is often overlooked.

3.10 The transport routes within the site for each material and equipment should be determined. The space required for the stacks of various materials should be worked out from the number of days-stock required. i. e. from a day's requirement of materials and the number of days to be allowed for delay in supply of these materials. For any big project it will be useful to prepare a space requirement chart marking the place for stacking materials, labour camps, office buildings, roads, etc.

3.11 It may be emphasised that the job schedules are of value only when the supply of materials and labour are assured in time. This is often difficult under the present conditions of controlled and short supply of steel and cement. To obtain the best advantage from a properly planned operation, Government should co-operate in assuring that controlled materials are supplied by them in time to facilitate rational planning. The naive may argue that the advantages of planning and site organisation accrue directly and indirectly to the contractor who undertakes to do the work at certain settled rates. In the long run Government stands to gain. It is to be expected that when the advantages of good preparation and suitable construction technique are known to contractors and they are confident at the time of tendering that there will be no hitch in the progress of work due to delay in supply of drawings and critical materials, they are certainly likely to reduce their quotation. For this purpose the necessity for installing confidance in the minds of tenderers regarding the determination of the department to conform to stipulated dates of delivery of materials, cannot be over emphasised.

3.12 An instance of wastage in materials was observed in the case of reinforcing rods. Due to lack of proper bar bending schedules for the entire project the contractors cut the pieces required at random from full lengths without keeping an eye on where and how the resulting cut pieces can be utilised in the project. In one of the building sites inspected, these cut pieces ranged from 2 ft. to 12 ft. lengths. These pieces of all dimensions were dumped provisionally in such a way that their subsequent re-arrangement in proper stacks would involve considerable labour. It was observed that while in some projects the wastage of reinforcement, in cut-pieces was as high as 10 per cent, in another it was as low as 1 to 2%. In the latter jobs it was observed that builders

and engineers had co-operated in reducing wastage by ordering the steel to required lengths and in cutting them as necessary in accordance with bar bending schedules. Considering the Government's anxiety in conserving steel it will be appropriate if the engineer-in-charge or his representative sits with the builder's representatives at the very earliest stage of the work, to prepare complete schedule of cutting and bending bars. The less qualified builders may have to be given technical help by the engineer, where necessary, to avoid un-economical cutting and wastage.

3.13 It has been mentioned earlier that there is practically no data regarding management of site operations and programming of work in this country. The loss in money and materials cannot be negligible. For lack of data it is not possible to bring this home to the operatives and the builders. It is, therefore, essential that a start should be made for collecting such data and conducting research in this direction. This is part of operational research at building sites, which we understand, is one of the functions of the National Buildings Organisation. It is suggested that a few building sites should be selected at random and the operations as they exist should be carefully studied from the inception of work to its conclusion so that the wastages in materials, manpower and money consequent on the various hindrances to the work, ill-planned stacking and disposal of materials, unbalanced labour strength and gangs may be evaluated. Observations may then be made on one or all buiding sites where all operations are programmed and managed according to a pre-determined schedule agreed upon by the contractor and the client at the time of tendering. It will then be possible to find out how far the principles on which the programme of work and operations are drawn up are accurate and to what extent they require modification for application in the case of general building site. It is felt that such studies will enable pinpointing of wastages and assessing its extent and value.

ADMINISTRATIVE AND CONTRACT PROBLEMS.

4.1 In the previous sections, we have dealt, in detail, with the technical side of the planning of work and site organisation. Apart from these, there are many administrative and contract problems connected with the construction of multistoreyed buildings which have important bearing on efficiency and economy of execution. These are discussed briefly in this section.

4.2 Before the execution of a work is taken on hand, there are four screenings through which the proposal has to pass :

(i) Administrative approval,
(ii) Expenditure sanction,
(iii) Technical sanction, and
(iv) Allotment of funds.

In the States, the second step of Expenditure Sanction does not exist and the allotment of funds and the Technical Sanction are sufficient authorisation for incurring the expenditure.

4.3 In the P.W.D's the cause of action in regard to a work arises when a requisition for the work is received from the client department. Based on this, preliminary plans and estimates are to be prepared and sent to the Department concerned for their agreement to general planning and administrative approval. On its receipt, the P.W.D. should proceed with the preparation of detailed plans and working estimates. These are technically sanctioned by the competent authorityof the P.W.D. after having satisfied that the works conform to the requirement of the client department, are structurally sound and complete in all respects. The actual execution are taken up after the allotment of funds.

4.4 Our enquiry, however, shows that a different procedure has been followed in the past. Although the C.P. W. Accounts Code lays down in para 6, appendix VI, that "they (Demands for new works) should be confined as a rule to those works only that have received administrative approval in cases where such administrative approval is required", provisions are made in the budget frequently without obtaining the administrative approval or the preparations of preliminary plans and estimates.

4.5 The user department obtains the Finance Ministry's concurrence without the advice of the C.P.W.D. and this, later on, is intimated to the W.H. & S. Ministry where the sanctions are consolidated and the totals worked out for new works. At this stage, the C.P.W.D. is consulted in a general way as to how much amount they can spend during the year. Based on their past experience they give an approximate idea. The file is then passed on to the Finance Ministry for obtaining the ultimate decision of the Cabinet of the amount that can be allocated to new works and works in progress. It is this amount that is provided for in the budget, after deciding the priorities in consulation with the various Ministries. The budget is then approved by the Parliament, and information is received by the C.P.W.D. some time in April/May. It is actually at this stage that complete conception of the work is realised. The C.P.W.D. then proceeds to prepare their plans of acquisition of land, and designs.

4.6 The procedure in some of the States like West Bengal is also not much different. There is no long-term planning of works and in its absence, it frequently happens that the time available for preparation of detailed plans and designs is insufficient, and to be able to utilise the budget provisions a great deal of haste is exercised. In a few cases due to want of time and detail designs even the whole work could not be let out for execution in one lot. Only the frame work was started and tenders were invited on the basis of rough estimates. In another case, even the estimates were not prepared and the work was started. The detailed designs and drawings were supplied piece-meal while the work was in progress. There are frequent instances of hold-ups for want of drawings and this is the major cause of new items of work not provided in the contract cropping up during the execution. Another cause is the client department changing their repuirements after the work is started.

4.7 In some cases, the extra items have been as many as the original number and the cost of these ranges from 15 to 50 per cent of the estimated cost. The additional work involves improvisations, delays and disputes with contractors. In such circumstances, there may be a tendency on the part of the contractors to provide a greater margin in their quotations.

4.8 In one case, additions and alterations of the buildings were being carried out even for a long time after its completion and occupation. This is in no way conducive to efficiency or economy of construction.

4.9 The above are the undesirable features of starting construction without full preparation. It is a practice that originated during the war to

meet the emergency but unfortunately has assumed a permanent character. Strong measures are needed to put an end to it. Incomplete planning leads to unpreparedness which, in turn, leads to improvisation involving inefficiency, bad quality of work and wastage of funds.

4.10 In the discussions we had with the officers of various departments, it has been argued that it is not absolutely necessary to finalise all the datails before going for tenders and construction and that, if they adhere to the procedure laid down, it will result in delay and additional staff would be required. This is not convincing. The detailed plans have to be prepared in any case whether before the start of the work or during construction. The man-hours required are the same. We could appreciate if the contention was that the additional staff is required to clear the backlog, and when once this is made up, no additional staff should be necessary for the future. At present due to financial stringency, works have been slowed down. The P.W.Ds should, therefore, be in a position to clear the arrears and for the future start with a clean slate.

4.10.2 Considering the overall benefits we have again to lay stress on our recommendation that building works should not be started without finalising all the architectural & service details on the basis of firm requirements of the user departments, and making arrangements for materials. It should also be ensured that structural details are made available to the contractor well in advance. A certificate to this effect should always be recorded by the authority sanctioning the estimate.

4.11 As regards administrative approvals and the allocation of funds, the procedure has been sought to be rectified by the issue of Government of India Ministry of W. H. & S., Memorandum No. BII-10 (17)/57, dated New Delhi the 30th November 1957, (Appendix VI) but no procedure has been laid down for long term planning.

4.12 The solution of advance budgetting for a period of 3 to 5 years has frequently been advocated, but actually never adopted. We cannot suggest anything better, if the Government wishes to obtain the best value for its money. A Member of the Team had an occasion to discuss the budget problem with the Town Improvement Authorities in Singapore who appear to have achieved excellent results both in town planning and economic construction of housing. They had a three years approved programme with priorities. A similar procedure in this country is strongly advocated. The priority should be real, and should not be changed midstream. In exceptional circumstances, it should only be done in consultation with all the departments affected and that only under orders of the secretary.

4.13 *Tendering*: The usual procedure of open tendering has been adopted for all works excepting two where selective tendering was resorted to. It may be conceded that in the open tender system, Government can get low quotations. But low quotations also connote low quality. Satisfactory quality can only be obtained by engaging efficient builders. For complicated and important types of works, and where quality work is required tenders should be issued to limited number of selected firms of approved performance in the type of work to be executed. In this way, the Government would be able to get the work of good quality with minimum departmental supervision.

4.14 The technique of building construction has made radical advance in Europe and America during the last two decades, specially in the line of prefabrication and mechanisation. In England, the use of tower crane alone has cut down the labour cost by 10%. In selective tendering, for works of special nature, the bidders may also be asked to give alternative designs and quotations. This will definitely afford the builders an opportunity to adopt modern methods.

4.15 *Time for completion of work*: The time allowed for construction has not been adhered to in any case except one. Extensions ranging from 25% to 80% of the time stipulated in the agreement were found to be granted in all cases reviewed by the Panel. The main reasons for extension of time are:

(a) Delay in supply of drawings;

(b) Delay in supply of materials; and

(c) Lack of co-ordination between different trades engaged on the building works.

4.16 In some cases, the time stipulated for construction was obviously too short. At present, there appears to be no formula for laying down the time for completing a particular type of building. We have come across certain standards in this direction recently formulated by the C.P.W.D. These are given in Appendix No. VII and may be taken as a guide for fixing the duration for the completion of a job.

4.17 As mentioned previously, the delay in supply of drawings can be avoided if the planning is complete.

4.18 Regarding materials there is no budgetting at present. Works are started without ascertaining whether there would be continuous supply of materials repuired for the job. This obviously, is a very unsatisfactory

and uneconomical procedure. The result is that all the jobs cannot be fed and there is all round delay and non-productive investment of capital.

4.19 We are informed that the Planning Commission has appointed a Committee for considering the problem of supply of scarce materials, and they had recommended the setting up of a cell in the Planning Commission for considering the problem of supply of materials and corresponding cell in the various executing agencies in the country who will keep continuous watch over the availability of materials and their probable production in the future. This would also collect necessary data regarding the requirement of materials of various agencies. This will enable the Planning Commission to give suitable allotment of materials, in short supply, to the executive agencies. We are in entire agreement with the objective of setting up of the organisation.

4.20 Lack of co-ordination between various trades working on a building has also contributed to delay in completion of work. We noticed work done by one trade being dismantled by the other leading to delay and disputes. This brings us to the important question of execution through a principal single agency with a suitable provision in the contract for subletting of special items of work to approved firms, so that the work may progress with harmony and the employer has to deal with minimum number of trades. It is argued that this system will lead to increase in the quotation. Considering, however, the advantages inherent in this method and its continued adoption in other countries, we recommend that this should be tried in a few cases and the result watched for future guidance.

4.21 *Payment to contractors*: We are glad to state that we have not noticed serious delays in payment of running bills, to the contractors, and normally, payments were made once a month. In one case, however, payments were made more frequently viz. at fortnightly intervals. Quicker payments to contractors naturally result in lower cost. It is, therefore, recommended that without any commitment in the tender, effort should be made to pay the contractor at more frequent intervals than one month that is normally provided in the agreement. Fortnightly measurements will impose serious strain on the Departments. Therefore, advance payments on the personal resonsibility of the officer-in-charge should be permitted. The position regarding the payment of final bills is, however, not satisfactory. Except in a few cases, payments were made to the contractor after a delay of 1 to 3 years from the date of completion. Here again, the additional items, are the cause of the delay. Considerable time was spent in correspondence in settling the rates etc.

4.22 The Committee of Experts on building works appointed by the Ministry of Works, Production & Supply in 1950 recommended that payments should be made promptly and not later than 90 days after completion of the work. The same recommendation was reiterated by the Committee appointed by the Works, Housing & Supply Ministry to rationalise contract forms. Unfortunately, it has not been put into practice yet. If our recommendations in the earlier part of this Chapter, regarding complete advance planning are adopted, the difficulty arising from the extra items would be considerably reduced and settlement of contractor's bills can be effected more promptly. Some extra items are inevitable, but they should be the exception rather than the rule.

4.23 *Arbitration :* In the cases studied by us, it has been found that reference to arbitration has been made in two cases so far, because of incomplete description of work in the tender. The Buildings Projects Team is dealing with the question of arbitration in greater detail in another report. Here it may, however, be emphasized that the description of the items in the schedule and specifications and the method of measurements should be standardized removing ambiguity and vagueness that now exists.

4.24 *Closing of accounts of work :* We have noted that the accounts of none of the works taken up for evaluation have been closed so far even though the works were completed a year or two back. The Reasons for non-closure of accounts are enumerated below :

(1) Delay in settlement of contractors' accounts;

(2) Delay in clearance of suspense balance in the account of work ;

(3) Disposal of surplus material at the site of work;

(4) Requisition for additions and alterations received by the user department.

The delay in the settlement of contractors' accounts is mainly due to the delay in the sanction of extra items and extension of time which has been dealt with in earlier paragraphs.

4.25 The clearance of suspense balance and the disposal of surplus materials is a problem at places where there is no central stores organisation. Where it exists the materials are returned to the stores and the clearance of suspense accounts can be effected promptly.

4.26 The Rates & Costs Committee appointed by the Ministry of Irrigation & Power recommended that all materials should be made to

pass through stock accounts. This can be achieved by creation of a store sub-division or a store division where there is a concentration of building activity.

4.27 We are informed that the user Departments frequently require additional work of extensions and improvements in the buildings and the expenditure on such items of work is debited to the major estimate of construction. This is a very irregular practice and must be put an end to. It is frequently the cause of the estimate being kept open for the purpose of debit of this unauthorised expenditure.

4.28 If the recommendations mentioned above are carried out, it is possible to close the works accounts within 4 months after the date of physical completion of the work.

SUMMARY OF IMPORTANT RECOMMENDATIONS

Serial No.	Ref. to para No.	
		I. *Space Utilisation*
1.	1.1	It is desirable to orientate a building so as to avoid exposure of the occupied rooms to Eastern and Western sun.
2.	1.2	The lettable office space or carpet area should be of the order of 65 to 75% of the total built up area.
3.	1.3.1	Clients' requirements should be ascertained in detail before undertaking planning of the building.
4.	1.4	Storage space must be properly planned.
5.	1.5	An area of 500 sft is considered adequate for Committee Room required to serve an office with carpet area of one lakh sft.
6.	1.7	The requirements of canteen should be assessed in each case separately and suitable provision made for the same.
7.	1.8.3	Scales for sanitary units fixed by ISI should be enforced.
8.	1.9	Space requirements of specialised services should be determined at the planning stage.
9.	1.11	8′ width for corridor is adequate to meet all normal office equirements.
10.	1.12	It is economical to construct independent light structures for garages and cycle sheds provided sufficient land is available.
11.	1.14	A height of 11′ from floor to floor is considered adequate.

12.	1.18	In view of the scarcity of teak wood and its rising prices, it should be advantageous to specify flush doors for office buildings where superior finish is required.
13.	1.19.2	Lift installation should be capable of transporting the whole population to the second and higher floors within 20 to 45 minutes.
14.	1.20	It is essential to decide the question of airconditioning at the planning stage as subsequent alterations are costly and cause inconvenience.
15.	1.25	A scientific study of the effect of shading window openings with louvers of various shapes and materials should be undertaken by the CBRI.

II. *Structure and Materials*

16.	2.5.11	A cavity wall appears to be the best proposition for external cladding.
17.	2.8	The type of frame with a central corridor of 8′ and rooms 14 to 16′ deep on one side and 25 to 30′ deep on the other side and with a spacing of 12′ is considered economical.
18.	2.15.2	There is need for setting up permanent centres at important places in the country for exhibiting building materials and advanced techniques of construction.
19.	2.19	Tested and untested variety of steel must be stocked separately and tested steel should be used for important projects like multi-storeyed buildings.
20.	2.19.3	It is advantageous to use richer mix for members which are predominantly in compression. Normal mix of 1:2:4 can be adopted for members subject to flextural stresses.
21.	2.25.2	The adoption of limited tendering is recommended to obtain quality concrete.
22.	2.26	Where foundation problems are complicated, expert on foundation engineering should be consulted and alternative foundation designs worked out.

23. 2.28 All construction agencies should supply data of the break-up of cost to the N.B.O. for consolidation and publication.

III. *Programming & planning of site operations.*

24. 3.5 All working drawings to 8th. scale should be made available with all information necessary for the completion of the building, right at the commencement of construction.

25. 3.13 A few building sites should be selected at random and the operations as they exist should be carefully studied from the inception of work to its completion in order to evaluate the wastage in materials, manpower and money due to lack of planning and organisation.

IV. *Administrative & contract problems.*

26. 4.10.2 Building work should not be started without finalising all the architectural and service details, on the basis of firm requirements of the user department and making arrangement for materials. It should also be ensured that structural details are made available to the contractor, well in advance.

27. 4.12 The adoption of 3 to 5 year approved programme with priorities is recommended.

28. 4.20 The method of letting out a work complete with all services to a general contractor may be tried in a few cases and the results watched for future guidance.

REMARKS BY THE SELECTED BUILDINGS PROJECTS TEAM.

The Report on Multistoreyed Buildings is a document which will have a far reaching influence on planning, designing and execution of such works. The Team participated in the deliberations of the Panel although only one member of it was associated with the Panel as its Chairman. The reason for the participation of the whole Team was that it was a subject of considerable importance and it would have led to duplication of work had the work not been undertaken on a combined basis by the Team and the Panel. The Team, while recording its appreciation of the work of the Panel, would like to underline a few important issues that require the consideration of the authorities concerned.

2. One of the important recommendations of the Report is that execution of such works should only be undertaken after complete details of planning and designing have been worked out. It has also recommended that, as far as practicable, arrangements should also be made beforehand for the supply of critical materials such as steel and cement not only in adequate quantity but also according to the correct specifications. The usual reason given for undertaking such works without detailed planning is that it was done under the pressure of the client department. The objective was that the structures should be available for occupation at certain target dates. In almost every case the target dates were seldom adhered to. On the other hand, the direct and indirect costs of holdups due to various factors, which could only be attributed to lack of planning, were considerable. It is, however, not worthwhile to work out details of such costs at this stage. The Team is convinced that if detailed planning is undertaken in the first instance, there will be saving in overall cost and it will be possible to lay down the target dates for the completion of such works in a more realistic manner than at present. The desideratum to be aimed at should be that the authorities concerned should go out to tender only after complete details of the buildings have been worked out. But in cases where it is not possible to do so and the work has to be started in anticipation of it, it is necessary that all architectural and service details and structural designs at least for the foundation and one or two floors should be fully worked out before tenders are invited. This is the minimum requirement if efficiency and economy are to be aimed at in the construction of such buildings.

3. The second important recommendation, to which the Team wants to draw pointed attention, relates to the norms that have been proposed for space utilisation. A range of 65 per cent to 75 per cent of the built up area has been laid down, for the usable space (carpet area) of the building. It gives a considerable scope within which the planners can operate depending upon several factors of a local character, such as the degree of freedom for planning depending upon site conditions, thickness of the outer and the partition walls, width of corridors and the room sizes etc., which cannot be anticipated on a general basis. It is not, however, the intention of the Team that the designers should be content with the minimum figure of 65 per cent, in view of the fact that a range starting from this figure has been indicated. The target laid down is 75 percent. Considering the economic aspect, the planners and designers should indicate reasons where this is not achieved.

The Team recommends that to improve space utilisation, the Government should follow the example of commercial firms and place a large number of office hands in big halls.

Most of the buildings examined by the Team do not work out to even the minimum of 65 per cent. One of the main factors is that some of the construction agencies have not sufficient time to work out the various alternatives and further the lay-out and designing of multistoreyed buildings had not reached the present level of evolution. It takes some time before designs come to a stage when they could be considered as economic and efficient. The Team estimates that if some of the buildings it has evaluated were to be replanned on the basis of the knowledge of design and construction techniques available today in the country as well as abroad, there could be a saving of about Rs. 50 lakhs.

4. The Team also notices that a low working stress in steel is being adopted by various Departments on account of part supply of untested steel. The strength of untested steel varies between a wide range, and this gives rise to different Departments adopting different working stresses for steel, leading thereby to uneconomic use of the material. It is, therefore, necessary that the untested steel should be marked with the manufacturer's certificate regarding physical properties of the steel. This will enable the designers to fix the working stress of steel on reliable data and will avoid the wastage that is at present occurring due to assumption of very low stresses for steel.

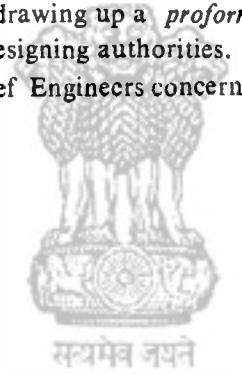
5. Another factor which should receive attention from the authorities concerned is the lay-out of the site of operation of such buildings. In view of the fact that the buildings are constructed on tender basis, the lay-out is now almost completely left to the contractor. If the contractors lay-out results in an expensive operation around the buildings, cost is inevitably reflected in the quotations given by him. It is therefore, necessary that the Engineers concerned should give greater attention to the lay-out of the sites for building operations than hitherto. The Team would suggest that the lay-out plan for each building should be prepared by the contractor who ultimately gets the contract in consultation with the Superintending Engineer concerned. Some of the considerations for this purpose have been laid down in Section 3 of the report.

6. The Team has also given considerable thought to the question of ensuring good quality. Apart from the administrative arrangements, which are still under study as they relate not only to multistoreyed buildings but also to all types of structures, the common complaint brought to notice was that cement bags as received in the godowns or on sites of works, were generally underweight. The shortage in some cases amounted to as high a percentage as 15. This naturally adversely affects the strength of the concrete as the mixing at present is generally done on the basis of the number of bags and not on actual weight. The concrete is also specified in terms of mix and strength. These factors give the contractor considerable latitude in the use of cement. Better control over the quality of concrete and economy in cement can be secured if it is specified by strength only. This necessitates that cement should be used by weight and not by volume or on the basis of number of bags. This could only be possible if weigh-batching could be introduced at sites at least in cases where large quantities of cement have to be used, such as the multistoreyed buildings. Small size plants of stationary and mobile types are being extensively used in other countries and they are such that it should not be difficult to manufacture them in India. We would suggest that the feasibility of construction of such plants may be examined by Government as we consider that the economy secured would far outweigh the capital expense that would be involved in such a venture.

7. As regards the shortage of cement in bags, it is necessary that a study should be made by a Team on the factors that lead to loss in transit, i. e., from the factory to the site. This study should also include a check of the weighing apparatus at the factories. This should

yield useful results for economy in cement as an interim measure it is possible to introduce weigh-batching as a matter of routine.

8. It is one thing to suggest norms on paper and another to apply them in practice. The important issue, therefore, is one of implementation of the norms suggested by the Team in actual practice. The recommendations of the Team are based on a consideration of the views of the Chief Engineers of some of the States who were consulted during the preparation of the Report. It commands general acceptance from them and it should not be difficult for them to lay down definite procedure for the implementation of the recommendations so made. It would perhaps be a good practice that whenever a justification of a building of this character is made out by the Engineering Authorities, a *proforma* should accompany showing the norms suggested by the Selected Buildings Projects Team and the extent to which they are realised. The Team itself is drawing up a *proforma* of this character for use by the planning and designing authorities. As soon as it is complete, it will be circulated to Chief Engineers concerned.

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APPENDIX 1

LIST OF MEETINGS HELD AND PERSONS WITH WHOM THE PANEL HAD DISCUSSIONS.

The first meeting of the Panel was held in New Delhi on the 27th & 28th June, 1957. under the chairmanship of Shri Sarup Singh. Shri R. R. Sarma, Shri K. Rama Varman and Shri Mahendru, members of the Panel, attended the meeting in addition to the Secretary. Shri A. Balakrishnan member of the Team, and Shri Inderjit Singh, Secretary, COPP'S, also attended the meeting.

The Second meeting was held in Madras on 22nd & 23rd July 1957. The third meeting was held in Bombay on 25th, 26th and 27th July 1957. The Panel visited many buildings in both the cities and had discussions with various officers. The list of officers with whom the Panel had discussions at both the places is given below.

At Madras :

Shri A.K. Raman, Accountant General, Madras.
Shri C.D. Kapur, Superintending Engineer, C.P.W.D; Madras.
Shri Nagendra, Resident Engineer, Life Insurance Building.
Shri Subramania Mudaliar, Contractor, A.G's Office Building.
Representatives of M/S Tarapore & Co., Contractors for Reserve Bank Building.

At Bombay :

Shri W. Mascarenhas, Chief Engineer, Bombay.
Brig. S.N. Dhar, Chief Works Officer. M.E.S.
Shri Allardic ICS (Retd.) Controller, Atomic Energy Commission.
Shri Yadav, Architect Bombay.
Shri S.V. Lonkar Under Secretary P.W.D.
Shri Havel, Executive Engineer, Bombay Division
Lt. Col, B.K. Ghose, C.W.E. Naval Works.
Shri I.D. Mathur, Executive Engineer, C.P.W.D.

The fourth meeting was held in Calcutta on 23rd. 24th & 25th August 1957. The Panel had discussions with Shri J. K. Banerji Chief Engineer West Bengal.

The fifth meeting was held in Chandigarh (Punjab) on 25th & 26th October 1957. The Panel had discussions with the following persons.

1. Sardar Hukum Singh—Chief Engineer, Capital Project.
2. D.P. Nayyar—Chief Engineer, Buildings and Roads.

The sixth meeting was held in Delhi on 28th & 29th October 1957.

The seventh meeting was held in Calcutta on 27th & 28th December 1957.

The 8th, 9th and 10th meetings were held in Delhi on 10th & 11th January, 13th & 14th Aug. and 4th & 6th November 1958 respectively.

FLOW CHART (A D M I N I S T R A T I V E)

Sr. No.	Particulars	Chandigarh	Queen Victoria Road Phase I.	Queen Victoria Road Phase III.	King Edward Road Phase II	King Edward Road Phase IV	Telephone Bhavan Calcutta	West Bengal Sectt. Calcutta.	Sachivalya Bombay	Ayakar Bhavan Bombay	A. G.'s Office Madras.
1	2	3	4	5	6	7	8	9	10	11	12
1.	Date of inception of idea.	23.11.51 Space requirements given to Architect.	2.2.52	2.2.52	19.11.53 No space requirements given. Order was to put up a building on K.E.Road similar to the one on Q. V. Road	19.11.53	—	27.10.50	1951	14.6.50	19.3.53
2.	Preliminary Estimate	12.7.55	5.4.52	8.1.54	Sent to Govt. on 4.2.54	8.1.54	25.1.49	25.1.51	Original preliminary estimate was prepared in October 1951. This was revised subsequently. Revised estimate prepared in April 1953.	11.10.50	25.6.53 Requirements revised by Auditor General on 1.8.53 and then revised preliminary estimate submitted.
3.	Administrative Approval	19.11.56	4.7.52	9.3.54	8.2.54	9.3.54	4.3.49	31.3.52	First Admin. Approval: 23.10.51. Revised Admin. Approval : 13.5.53	19.10.51	2.12.53
4.	Expenditure sanction	—	—	—	17.3.54	6.7.54	—	—	—	—	15.4.54
5.	Technical sanction	Technical sanction for frame & foundation accorded in Mar. 57 when the work of frame was practically completed.	5.8.52	5.8.54	15.5.54	8.7.54	(a) Founds: 20.9.50 (b) Steel Structures:— 18.11.50 (c) Super Structures:— 25.11.50	25.7.55	(a) For foundations 13.7.53 (b) For Super Structure 14.11.53 (c) Extra floors 5.11.54	12.9.52	6.9.54
6.	Date of inviting tenders	17.7.53 (for frame)	—	12.1.54	August 1954. Tenders reinvited 11.10.54	18.10.54	(a) 8.11.50 (b) 20.6 .51	—	Foundation: work was done by negotiation. For super-structure 4.11.53	18.7.52	30.9.54
7.	Date of Start of work	For frame 8.9.53	27.8.52	18.1.55	24.1.55	24.1 .55	30.12.49	27.3.51	Foundation: 1.8.53 superstructure 24.11.53	4.12.52	27.12.54
8.	Stipulated time	24 months	22 months	18 months	18 months	18 months	57 months	35 months	21 months	24 months	24 months

1	2	3	4	5	6	7	8	9	10	11	12
15.	Payments to Contractors	Not regular	Regular	Regular	Generally once a month	Generally once a month	Generally once a month	Generally once a month	Very prompt-twice a month, occasionally including advance payments	Regular	Regular
16.	Settlement of Final bill.	Not paid though building was completed on 31-3-57 and bill prepared on 17-9-57. Delay is due to settlement of deviated or extra items.	5/57	Not yet paid, though the contract was completed on 14.4.57 Delay is due to sanction to extension of time and extra and substituted items.	Not yet settled though the building was completed on 31.12.56. Delay is due to non-sanction of extra items and extension of time.	Not yet settled though the building was completed on 23.3.57. Delay is due to want of sanction to extra and substituted items and extension of time.	Final bills for all contracts have been paid except that relating to building. misc. items.	All final bills have been paid	Final bill paid. Building completed on 23.5.55. No delay in payment	Final bill has been paid.	Final bill not yet prepared
17.	Claims of contractors and arbitration	Claims worth Rs. 3,44,412 i. e. 5% of tendered amount. Claims are due to loose specifications. Arbitration award awaited.	3 Items were referred to for arbitration. All of them were decided in favour of the contractor involving a payment of Rs. 33,568/-	Nil	Nil	Nil	Nil	Nil	Nil	Extra payment for rendering R.C.C. lintels, beams, columns, etc. with C. M. 1:4 of thichness ¼" has been awarded. Amount :- Rs. 17,892/-	No claims final bill not yet prepared.

APPENDIX III

TECHNICAL DATATA REGARDING VARIOUS MULTIS

S. No.	Particulars	Standards	Punjab Secretariat CHANDIGARH	Multistoreyed office building, King Edward Road, NEW DELHI	Multistoreyed Building, Queen Victoria Road, NEW DELHI	Telephomone Bhavan CALCUTTA	West Bengal Secretariat, CALCUTTA
1	2	3	4	5	6	7	8
1.	Total plinth area	...	5,95,600 sq. ft.	4,79,952 sq. ft.	4,83,192 sq. ft.	2,58,341 sq. sq. ft.	2,81,073 sq. ft.
2.	Percentage coverage with respect to plot.	33½ to 50 for 6 storeyed building.	...	28%	...	... ...	...
3.	Carpet Area	...	3,25,000 sq. ft.	2,90,135 sq. ft.	2,80,135 sq. ft.	1,73,578 sq. sq. ft.	1,69,777 sq. ft.
4.	Percentage of C. A. to P. A.	65 to 75	54.6%	61%	58%	67.57.2%	60.41%
5.	Orientation	East & West exposure to be avoided.	Because of Western & Eastern exposure sunlouvers of elaborate design had to be used.	Good	Good	... ...	...
6.	Area occupied by External walls, & External columns	3% of P. A.	0.5%	3.5%	3.5%	5.21.21%	1.53%
7.	Area occupied by Internal walls & Partitions	1½ to 2% of P. A.	5.0%	2%	2%	0.99.9%	14/28% (includes area of columns & fins).
8.	Clear width of corridor	8 ft.	9'-9"	9'-0"	9'-0"	... ...	8'-0"
9.	Area of horizontal circulation space. including corridors, passage etc.	12-14%of P. A.	23.5%	About 20%	About 20%	6.33.33%	13.58%
10.	Entrance halls & lobbies.	1-1½% of P. A.	5%	Less than 0.5%	Less than 0.5%	2.17.17%	1.25%
11.	Lifts.	One per 30,000 sq.ft. of P. A.	1 per 66,000 sq. ft. Total 9 nos.	One per 40,000 sq.ft. Total 12 nos.	One per 40,000 sq.ft. Total 12 nos.	... ..	...
12.	Disposition of staircases	Travel distance 150 ft. maximum.	Satisfactory	Satisfactory	Satisfactory	Satisfactory y	Satisfactory
13.	Area of vertical circulation. i.e. lifts and staircases.	4 to 5% of P. A.	9%	4%	4%	4.39.3%	5.25%

,	Sachivalaya, BOMBAY	Ayakar Bhavan, BOMBAY	A. G. 's Office, MADRAS	Mafat Lal House, BOMBAY	Reserve Bank, MADRAS
	9	10	11	12	13.
	2,81,462 sq. ft.	2,18,575 sq. ft.	1,24,673 sq. ft.	46,134 sq. ft.	2,70,160 sq. ft.
	...	...	...	...	...
	1,59.812 sq. ft.	1,28,849 sq. ft.	84,070 sq. ft.	32,592 sq. ft.	1,68,850 sq. ft.
	56.7%	58.9%	67.4%	70.6%	63.70%
	Good	...	Sun louvers had to be adopted due to Western and Eastern exposure.	...	...
	10.4%	4.4%	5.5%	8.90%	1.85%
f		1.27%	2.6%	1.70%	1.26%
	9'-0" & 9'-6"	8'-0"	8'-6"	...	6'-0" to 10'-0"
	17.5%	17.7%	11%	6.30%	9.44%
	3.27%	1.9%	6.5%		1.22%
	1 per 35,200 sq. ft. Total 8 nos.	...	One per 60,000 sq. ft.		Total 5 nos. i.e. 1 per 54,000 sq. ft. of P.A.
	Satisfactory.	Satisfactory	Satisfactory	...	...
	6.7%	2.1%	4.1%	3.90%	4.9%

1	2	3	4	5	6	7	8
27.	Windows	Steel windows prefered. % of window to C. A. 15%.—20%	58%	Wooden frames and glazed shutters 11%	Wooden frames and glazed shutters 11%	The windows consist of glazed steel casement. In addition Alluminium louvres have been given from outside from Ist floor to 7th floor to main building. The windows in corridors of 8th floor consists $\frac{1}{4}$" thick wire glass in frame with 2"x$\frac{1}{2}$" teak cover moulds.	Mostly steel windows
28.	Flooring	Superior flooring to be 30% to 40%.	General offices & Ver. Cement concrete floors. Corridor linolium, Ministers rooms-black marble floor. Public places stone flooring. Mosaic floor about 45-50%	Mainly ordinary Cement concrete. $1\frac{1}{2}$" thick mosaic floors only in corridors, lobbies, WC's & about 25% of office rooms. Marble floor in main entrance. Superior floor about 30-35%	As per King Edward road building	Thickness of flooring $1\frac{1}{2}$" over R. C. C. Slab. (a) Corridors-Patent stones with 6" skirting both sides. (b) Central Hall, G. F. Italian Marble. Other floor-Mosaic. (c) Basement-Patent stone (d) Officers' Room-Patent stone (ii) Mosaic (e) W. C., Canteen & Cafeteria)Mosaic.	Thickness of flooring 1". 1" patent stone flooring except in stairs, lobbies, canteens, W.C.lavs where mosaic flooring has been adopted.
29.	Cost per sq. ft. of plinth area including internal water supply drainage sanitary installations, electrical installations.	Suggested rate Rs. 18 to 21 based on costs of material and labour prevailing in 1958.	Rs. 22.8	Rs. 16/-	Rs. 16/-	Rs. 38.14	Rs. 28.18
30.	Cement per 100 sq. ft. of plinth area.	1.5 to 1.75 Tons	1.10 tons for frame & foundations only.	1.61 Tons	1.76 Tons	2.37 tons	1.6 tons
31.	Steel per 100 sq. ft. of plinth area.	0.5 to 0.7 Tons	0.57 tons for frame & foundations only.	0.65 Tons	0.69 Tons	(a) Structural Steel— 1.24 tons (b) M.S. Bars :—0.46 tons Total 1.70 tons	(a) 0.56 Tons (b) 0.47 tons Total 1.03 Tons

9	10	11	12	13	5
Mostly steel windows 23.3%	Steel windows 18.6%	Office Teak wood glazed Windows Record Room—Steel Windows 13%	Burma Teak Frame 15%	Steel windows 7%	
Marble Mosaic tiles right through corridors etc. Marble floor in entrance halls & public places. Plain cement tiles in office. White glazed tiles with dados in public WC's & Marble tiles with dados in Officers WC's	Marble Mosaic flooring except basement.	Mosaic tiles for corriors halls & lobbies & staircases Marble floors at entrance. Other portions only C.C. floor Superior floor:—25%	Marble Mosaic tiles of approve/make & colour laid complete on 1" lime mortar bedding cement floated including polishing.	Corridors:-(i)Marble mosaic (ii)Granolithic & (iii)cast Iro grid flooring. Public places:- Marble mosaic.Officers Room-Marble Mosaic. Office Room:- do WCs & Lavs: white glazec tiles. Note:- 120 Tons of Pig Iron for manufacture of cast Iron Grid flooring.	
Rs. 22.7	Rs. 14.78/-	Rs. 17.45/-	Rs. 17.9 but excludes services.	Rs.26/-(This includes pile founds & const. of vault rooms but excludes special vault reinforcement, airconditioning lifts & professional fees).	
1.94 Tons	1.64 tons.	1.62 Tons.	2.12 Tons.	2.90 Tons	
0.46 Tons	0.52 Tons.	0.55 Tons.	0.59 Tons.	0.55 Tons.	

APPENDIX IV

REVIEW OF THE DESIGN AND CONSTRUCTION OF MULTISTOREYED BUILDINGS IN VARIOUS STATES.

(1) Krishi Bhavan, Queen Victoria Road, New Delhi.

(2) Udyog Bhavan, King Edward Road, New Delhi.

(3) Accountant-General's Office Building, Madras.

(4) Ayakar Bhavan, Bombay.

(5) Sachivalaya, Bombay.

(6) Telephone Bhavan, Calcutta.

(7) West Bengal Secretariat Building, Calcutta.

(8) Secretariat Building, Chandigarh.

Note: –The reviews of the above schemes given in the subsequent pages are based on data made available to us till the end of January, 1958.

1. KRISHI BHAVAN QUEEN VICTORIA ROAD, NEW DELHI

I. *Administrative and financial*

The building was constructed in two phases. Phase I was administratively approved in July 1952. Due to want of details, it was decided to let out the frame work first and the cloaking work later. The estimate for the framework was prepared on the basis of line plans and it was technically sanctioned in August 1952. The work was started in the same month and was stipulated to be completed within a year. But the framework was actually completed on 7.3.55, after a period of 2 years, 6 months and 9 days. The delay was more than a year and a half.

The original contract for framework contained 20 items amounting to Rs. 16,31,277. Several extra items and substituted items cropped up during the execution. The extra cost of those which are 27 in number comes to Rs. 3,27,868 which forms 20% of the amount of the contract.

The cladding work was started on 15.3.54 with a contract period of 10 months. It was completed on 31.12.55 after a delay of nearly one year. There were 53 items included in the original tender amounting to Rs. 10,18,518. In the course of execution 55 extra and substituted items cropped up. The cost of these items is Rs. 1,79,444 ie., 16.6% of the initial contract amount.

For the other phase of construction (Phase III) the framework as well as cladding work were given to the same contractor. This has resulted in comparatively quicker completion of work. The original contract was for 106 items costing Rs. 27,91,304. 31 extra and substituted items were executed. The cost of these items is Rs. 86,792 which forms 3.1% of the initial contract amount.

The large number of extra and substituted items were obviously due to incomplete planning. Had more time been given for this purpose, it would have been possible to frame an estimate on the basis of well prepared detailed drawings. The contractor for phase I of the construction had referred three claims to arbitration, which were decided in his favour.

II. *Space Utilisation*

The building is a seven storeyed one with an average floor height of 11 ft. The proportion of carpet area to plinth area works out to 58%

The area of horizontal circulation is on the high side and this may be due to frame arrangement. Area of vertical circulation is, however, within limits.

Sufficient number of urinals and WC's have been provided but the location of the units is not convenient.

As the building was evidently constructed without a decision as to the departments which are to occupy it, several alterations and modifications had to be done later to suit the individual requirements of the various departments which have moved into the building resulting thereby in prolonged additions and alterations.

III. *Structural design and planning.*

The design has been carried out on the basis of well-known principles of frame analysis. The stresses and loading adopted are in order except for the working stresses of steel which have been taken as 16,000 lbs. This was due to non availability of tested steel.

IV. *Specifications and cost.*

The cost of building including internal water supply and sanitary installations and internal electrical installation comes to Rs. 16 per sft of plinth area which is quite reasonable. Consumtion of cement and steel is also normal.

V. *Execution and arrangement for materials.*

As indicated earlier, there was delay in execution due to late supply of drawings and delay in supplying materials. Due to non-availability of mild steel bars in proper lengths, there was certain additional consumption due to overlaps. Advance allocation of materials like Cement and Steel is, therefore, essential if the work has to be executed with speed and economy.

2. UDYOG BHAVAN KING EDWARD ROAD, NEW DELHI

I. *Administrative and financial*

The building was constructed in two phases. Phase II was administratively approved in February, 1954. The estimate was technically sanctioned in May, 1954. Work was started at the end of January, 1955 and was stipulated to be completed within 18 months. Actually it was completed on 31-12-1956 i. e. the delay was about 5 months.

The original contract contained 101 items amounting to Rs. 25,68,429. Several extra and substituted items cropped up during the execution. The extra cost of these about 60 in number comes to Rs. 3,37,980/- ie., 13% of the cost of the initial contract.

Administrative approval was accorded for phase IV in 7/54 and technical sanction was accorded in 7/54. The work was started at the end of January, 1955 and was stipulated to be completed within 18 months, but actually it was completed on 31-5-1957. The delay was by about 10 months.

The original contract contained 95 items amounting to Rs.29,00,016/-. Several extra and substituted items cropped up during the execution. The extra cost of these which are 49 in number, comes to Rs. 4,47,128/-, which forms about 15.3% of the contract amount.

The large number of extra and substituted items primafacie can be attributed to incomplete planning probably due to lack of time. Had more time been made available, it should have been possible to frame the estimate on detailed drawings.

II. *Space Utilisation.*

The building is a seven storeyed structure with an average floor height of 11 ft. The proportion of carpet area to plinth area works out to 61%.

The area of horizontal circulation is on the high side and this may be due to frame arrangement. Area of vertical ciculation is, however, within limits.

Sufficient number of urinals and WC's have been provided but the dispersal of the sanitary units is not well thought out.

The building was constructed without any prior decision as to the department that was to occupy it. This has led to some readjustment of doors and partitions, to suit the user requirements.

III. *Structural design and planning.*

The design has been carried out on the basis of well known principles of frame analysis. The stresses and loading adopted are in order except for the working stress for steel which have been taken as 16,000 lbs. This was due to non-availability of tested steel.

IV. *Specifications and cost.*

The cost of building including internal water supply and sanitary installations and internal electrical installation comes to Rs. 16 per sft. of plinth area which is very reasonable. Consumption of cement and steel is also normal.

V. *Execution and Arrangement for materials.*

During execution tests were carried out, and the results are satisfactory. There had been some delay due to difficulty of procuring materials.

3. ACCOUNTANT GENERAL'S OFFICE BUILDING, MADRAS

I. *Administrative & Financial*

The idea of providing a separate building for the office of the Accountant General in Madras dates back to early 1953. Preliminary estimates were sent to the Government in June 1953, but they were subsequently revised in August, 1953 to provide for the revised requirements of accommodation. Administrative approval amounting to Rs. 23,11,000/- was accorded in December, 1953 and 'expenditure sanction' in April 1954.

The estimate for the building portion was prepared and accorded technical sanction in September, 1954. Tenders were invited at the end of September, 1954, and a notice of only 15 days was given. For a project of this magnitude, the time given is obviously insufficient. At least a notice of one month should have been given to enable the tenderers to study the plans and work out their lowest bids. The object of competitive tender is defeated by giving short notice. The lowest tender of Rs. 11,79,313/- against the estimate of Rs.12,27,916/-, was accepted.

The work was started on 27/12/1954; the stipulated time for completion was 24 months, ie., it should have been finished by December 1956, but it is still in progress.

It is reported that there has been a delay of 6 months on account of the non-availability of mild steel bars and about 3 months on account of non-supply of architectural and structural plans. A further delay of 2 months has been attributed to the additional work that was found necessary during construction. Even taking all these factors into consideration, the building should have been completed at the latest by the end of October, 1957, but as remarked above, the work is still in progress.

It appears that the tenders were called on inadequate planning, which has resulted in work that was not catered for in the tender and there has also been delay in decision regarding finishing of the building.

The Chief Engineer has observed that this was due to the administrative departments usually hustling the Public Works Department to shorten the period of planning so as to call tenders quickly and commence

the work. The Chief Engineer has also added that in these days of large scale activity when every department wants quick results, it is not always possible for C.P.W.D. to spend adequate time for planning and call for tenders. This aspect of the question is dealt with in the body of the report in detail.

Since the work is still in progress, the final bill has not been prepared. It cannot be definitely stated whether there will be any claims beyond the tendered items, but since the contractor has been expressing his difficulties on account of premature occupation of parts of the building it looks as if he will raise claims for compensation.

One can imagine the contractor's difficulties in completing the work, when a substantial part of the building is in use. It must inevitably interfere with finishing jobs, specially floor polishing, plastering, whitewashing and polishing of woodwork. It would have been a better procedure if the tender agreement had provided phased completion of the building so as to avoid the eventuality of claims for compensation from the contractor and also secure smooth progress in the work.

II. *Space Utilisation :*

The building is a five-storeyed structure (ground floor and 4 upper floors) with an average floor height of 11 ft. It is of R.C.C. frame construction with brick filler walls. The total plinth area is 1,24,673 sft, and carpet area is 84,070 sft. which comes to 67.4%. This can be considered satisfactory.

The space utilisation for the horizontal and vertical circulation is within reasonable limits.

It is noticed that the following scale of accommodation has been allotted to offcials of various grades:

Clerks.	50 sft.
Sec. Heads	250 sft.
Dy. A. G.	450 sft.
A. G.	650 sft.

The space allotment to higher officers is on the liberal side, and could have been reduced without in any way affecting their comforts.

III *Structural Design & Planning :*

The building is a central corridor type with a 25′ deep rooms on either side. The clear width of corridor is 8′-6″. The adoption of 25′ depth on

either side creates difficulties in attaining well proportioned rooms. It becomes too long for efficient space utilisation.

The position of a separate block for the storage of permanent records is a welcome feature. It makes it possible to provide rooms with low ceiling height. The whole vertical space is efficiently utilised. Further, it results in uniform structural design for heavy loading of the records.

The block has, however, a single narrow stair-case. This obviously is insufficient. An additional stair-case for fire escape is necessary.

The location of the canteen in a separate block is a good feature, but the garages have been located in the ground floor of the block, which is ultimately to be a four-storeyed structure. The construction of garages as part of the multistoreyed building does not prove economical. In the present case, there is no land problem, so it would have been advantageous to construct the garages separately.

As a result of orientaion of the building, it has been found necessary to provide sun control louvers on all sides. This adds to expenditure.

The Chief Engineer has explained that the orientation of the building was governed by the main road running in front of the plot. The facade of the building had necessarily to be kept parellel to the road.

Services do not go well along with other specifications of the building. Conduit wiring would have been more suitable.

The arrangements for drinking water do not appear to have been considered at the planning stage. As a consequence, some isolated fountains have been placed in the corridors which give it a very untidy look.

It is understood that all the beams have been designed to take up $4\frac{1}{2}$" brick partition walls. This is a wasteful practice. In office building designed for specific requirements there should have been no difficulty in determining in advance the location of all partitions. Future requirements can be met with lighter construction.

The Chief Engineer while agreeing with the view of the Panel has remarked that the administrative department usually ask for construction and dismantling of partition walls frequently and that these requisitions do not follow a set pattern. He has, therefore, stated that the existing practice of designing of all beams for carrying partition walls should continue.

The loading is according to the I. S. I. standards but the stress in steel is taken as 16000 lbs. per sq. inch due to non-availability of tested steel.

IV. *Specifications & Cost :*

Door shutters are made of plywood hard boards $1\frac{3}{4}$" thick. It is considered that $1\frac{1}{2}$" thickness should have sufficed.

There is no necessity to provide double shutters for the office rooms. Single doors 3'-4" wide would have proved more convenient and economical.

All the urinals are of stall type. It is sufficient if the urinals at the main entrance are of stall type and others of lipped type. Though stall urinals are more hygenic they involve high cost and foreign exchange.

V. *Execution & Arrangement for Materials :*

No detailed programme of work seems to have been drawn up; only the progress chart was prepared by the department.

For quality control, test of concrete and mortar have been carried out during the execution of the work.

The work has been held up for six months due to delay in the supply of mild steel reinforcement.

4. AYAKAR BHAVAN, BOMBAY.

1. Administrative and Financial :

The decision to erect an eight storeyed building for housing the income tax offices in Bombay was taken in 1951, and administrative approval for Rs. 42,44,400/- was accorded in October, 1951. The working estimate amounting to Rs. 35,69,900/- was sanctioned in September, 1952.

A period of one month was given for submission of tenders. About 19 tenders were received, and the lowest amounting to Rs. 26,70,394/-, which comes to 79% of the estimated amount was accepted.

The work was started on 4/12/1952, and was scheduled to be completed by 3/12/1954, but actullay, it was finished on 28/2/1955. The time was extended on account of the delay attributed to the following reasons:—

(a) Half of the work site was not handed over in the beginning, till a period of 2 months after start of the work.

(b) Detailed structural and architectural drawings were supplied piecemeal during the execution of work. The last drawing, supplied as late as 31/1/1955, viz. one month before the actual date of completion of work.

(c) Mild steel bars were not available from the Stores and the contractor had to make his own arrangements to purchase about 55 tons from the open market.

The total number of items for which the contractor was paid were 83 against 54 provided in the tender. There was however, no corresponding increase in the over all cost as the expenditure under additional items was covered by saving in other items.

The study of the figures and the timing above shqws that the original estimates were loosely prepared on the basis of incomplete data. There was a gap of 11 months between the date of administrative approval and the technical sanction, which gave sufficient time for detailed planning and accurate estimating.

The Chief Engineer, C.P.W.D. however, has pointed out that actual time given to the department for preparation of detailed drawings and

estimates was much less as the Government could not decide as to what department was to occupy the building till June 1952. The time therefore at the disposal of the Public Works Department was very short and they could not prepare detailed drawings and estimates.

The running payments were regular and the final bill was paid soon after the completion of the work.

There have been two references to arbitration, one regarding the contractor's claim for credit of the full issue rate for the mild steel cut pieces returned to the Department and the other regarding extra payment for rendering R.C.C. lintels, beams, columns, slabs etc. The first was rejected but for the second he was awarded Rs. 17,892/-. It shows that the specifications and schedule of rates for R.C.C. work are vague, and do not fix clearly the contractor's responsibility for rendering of the R.C.C. work.

The Chief Engineer has stated that the specification of items have now been amplified to avoid any further ambiguity and dubiousness.

II. Space Utilisation :

The building is a 8 storeyed structure with basement and seven floors. The average floor height comes to 11ft. The total plinth area of the building is 2,18, 575 sft. Out of which 1,28,849 sft is the carpet area, which comes to 58. 9% of the total plinth area.

The main staircase in this building is taken round the lift. In public buildings, it is desirable to avoid this arrangement as this leads to traffic interference. Further, it is also desirable to have entrance halls commensurate with the total strength of the office.

III Structural Design & Planning.

The building has R.C.C. columns and girders with brick filler walls. The thickness of the external Walls is 13½". By adopting cavity wall construction, the load of the walls could have been reduced, thus resulting in reduction of the dead load.

The partition walls are constructed of brick on edge instead of the usual 4½" thickness. This is certainly an improvement over the normal practice.

The design has been prepared after regular frame analysis. The loading and stresses assumed are in order except for the working stress for the mild steel which has been taken at 16,000 lbs. per sq. inch.

The procurement of tested steel would have resulted in saving of steel, and probably also in cost.

The Chief Engineer has explained that tested steel could not be obtained due to the general steel shortage. This brings in the necessity for budgetting of materials which is dealt with elsewhere in the report.

The adoption of the surface wiring does not go well with the quality of building. Conduit wiring was called for.

The Chief Engineer has stated that the department was following conduit wiring in later buildings.

IV. *Spacifications & Cost*

Specification and finish of doors provided in the building are not in keeping with other specifications. Flush doors would have proved better for a building of this type.

The Chief Engineer has stated that at the time of planning flush door had not come to such prominance. He, however, added that his department has started specifying flush doors for such buildings.

The original attempt at waterproofing of the basement did not prove successful. The specifications were 1:4:8 concrete with $1\frac{1}{2}$" thick topping mixed with 5% composeal and a floating coat of neat cement. After its failure, some patent method of water proofing had to be resorted to. It may be emphasised that waterproofing of a basement is a very important matter, and should receive careful attention both in drawing up the specification and execution.

The total cost of construction including internal water supply and Sanitary installation and internal electrification comes to Rs 32,26,041. The plinth area rate therefore comes to Rs. 14.78 per sft. which is very reasonable.

The consumption of cement and steel are within normal limits.

V. *Execution of work & quality control*:

No time schedule of the works seems to have been prepared either by the department or by the contractor. Only monthly progress charts are availabele.

Concrete and mortar tests appear to have been made during the progress of the work. The quality on the whole is good except for the joinery. The Chief Engineer has stated that the bad quality of joinery was due to the shortage of seasoned timber.

5. SACHIVALAYA, BOMBAY.

I. *Administrative & Financial :*

The Government of Bombay decided in 1951 to construct a multi-storeyed Secretariat building, to house its various departments which were then located in different places in the city. The initial administrative approval was given in 1951, but as a result of the enhanced scope of work, the revised approval was accorded in 1953.

The estimate for the foundations amounting to Rs. 4,67,584/- was given technical sanction in July 1953. The contract was let out by negotiation and the work was started on 1st August 1953. Technical sanction for the work of the superstructure was given in November 1953.

The Tenders for the work were invited from nine selected firms of contractors. Out of these, six sent their quotations.

The time allowed for the tender was barely a week. This obviously is far too short for a work of the magnitude of the Secretariat building costing in all about Rs. 52,76,833/-. It does not give even sufficient time for a proper study of the nature of the work to enable the contractors to work out their lowest bids. This is borne out by the large difference between the highest and lowest quotations (highest was Rs. 44.2 lakhs and the lowest was Rs. 33.98 lakhs against the estimated amount of Rs. 32.55 lakhs.)

The system of selected tendering, it is stated, was adopted to save time and complete the construction within as short a time as possible and the short-notice is justified on the ground that Bombay possesses a sufficient number of experienced contractors, who are able to give reasonable bids at short notice.

The time stipulated in the tender for the completion of the work of superstructure was 21 months, but the contractor agreed to execute it within 18 months. It is satisfactory to note that this time schedule was adhered to, although during the execution there arose a large number of additional items of work. The total number of items of work in the original contract was 213 while the additional and substituted items were 205. The cost of the new items was as much as Rs. 13,87,622/-, which is more than 40% of the original contract amount.

It appears that the technical sanction was accorded on the basis of only line diagrams prepared by the Government architect. The detailed architectural drawings and structural designs were supplied piecemeal during construction. Though there does not appear to have been any interruption in the work due to non-availability of the plans, it is obvious that the lack of detailed plans at the time of start of the work, has led to a number of new items.

II. *Space Utilisation :*

The secretariat building is primarily a 6 storeyed structure with R.C.C. framework and brick filler walls.

The plinth area of the building is 2,81,462 sft. whereas the useful carpet area is 1,59,812 sft., which comes to 56·7%. This is somewhat low.

The horizontal circulation space comprising the corridors, passages and verandahs comes to 17.5% of the plinth area, which is slightly higher than the usual proportion of about 15%.

The window area comes to 23.3% of the carpet area, against the normal proportion of 20%.

It can be said that on the whole, there is a margin for improvement in space utilisation.

III. *Structural Design and Planning :*

The framework has been designed without considering the factor of continuity. A rigorous design after the necessary frame analysis would have resulted in saving its cost and materials.

The Chief Engineer, while accepting this view, has stated that it was not possible to adopt the rigorous design method on account of paucity of staff and urgency of the work.

Filler walls consist of 14" brick work which considerably adds to the dead load, thus increasing the cost of frame work and foundations. Probably the 14" thick walls were adopted as a measure against moisture penetration.

Further the heavy brick pillars-presumably adopted from purely architectural considerations must have also made a sizeable contribution to the dead load of the structure.

The adoption of a richer mix, say, 1: 1½: 3 or even 1:1:2 would have resulted in an overall economy, reducing the size of the columns and, in

consequence, the dead load. The size of the columns is, however, contended to be justified on architectural considerations.

The loads and stresses assumed in the design conform to accepted practice.

IV. *Specifications & Cost* :

The building is well-finished. The provision of wooden panelling in almost all the corridors and a large number of rooms has, however, appreciably added to the cost.

The over-all figure of cost works out to Rs. 22. 7 per sft. of plinth area, inclusive of internal electrical and sanitary services.

The cement consumption comes to 1.94 tons for 100 sft. of plinth area. This also is high, and is attributable to the method adopted in the structural design.

V. *Execution & Arrangement for materials*

The work was completed within the stipulated time inspite of the fact that many details had to be settled durig the execution of the work. The wastage of steel is low.

Though a detailed programme of work has not been drawn up at the first instance, the execution of work appears to have been pushed through with promptitude. The supply of materials was regular and no hold-ups due to non-supply of any of the essential materials has been observed.

The workmanship is good.

6. TELEPHONE BHAVAN, CALCUTTA

I. *Administrative and Financial*:

Administrative approval for an expenditure of Rs. 72.56 lacs was accorded in March, 1949 for the construction of ten-storeyed building for installing Automatic Telephone Exchange, Bank and City. Detailed drawings were furnished by the Architect for the steel structure in July 1949, and for the super-structure piecemeal from September, 1949 to December, 1949. The estimate of the scheme was technically sanctioned under three sub-heads:—

	Date	*Amount of sanction*
(i) Pile foundation.	20-9-1950	Rs. 9,43,300/-.
(ii) Steel structure.	18-11-1950	Rs. 37,30,400/-.
(iii) Superstructure including sanitary.	25-11-1950	Rs. 46,65,100/-

The Dalhousie site was acquired by the Government for the erection of Telephone Bhawan. The old structure has been dismantled. At the instance of the P & T. Department, Messrs. Ballardie, Thompson and Mathews, private architects, designed and prepared the detailed plans and specifications for the entire work and the C.P.W.D. acted only as the Executive Agency on behalf of the P & T. Department. Estimate for the foundations, steel structure and other items were prepared by Messrs. Ballardie, Thompson & Mathews, but were priced by the C.P.W.D. for the purpose of technical sanction.

Messrs. Braithwaite, Burn Jessop & Co., Limited were entrusted with pile foundation as they are the agents for Franki piles. In regard to other items, tenders were called for and the lowest accepted.

The time limit fixed for completion of the various sub-works was not adhered to, except in the case of pile foundation. The dates fixed for completing the steel frame, filler work, miscellaneous items relating to building work and sanitary work were 10-11-1950, 9-10-1952, 31-3-1953 and 4-11-1953 respectively. The actual completion dates were, however, 6-1951, 5-1953, 7-1954 and 5-1954 with a carry over delay of about 6 months. Apart from the delay in execution of work, due to delay in supply of steel by the Department and on account of the monsoon rainfall,

delay was also caused by the P. & T. Department, making changes during the execution of the work.

The building was occupied even before it was completed. As a result, the building contractor was not able to carry on with his work methodically and had to wait till portions were vacated.

II. *Space Utilisation :*

The building is a ten-storeyed one (Basement, Ground and 8 upper floors). The building is a steel-framed one with steel stanchions and beams with R. C. C. in slab and other places as necessary. The total plinth area of the building is 2,58,341 sft. and the carpet area is 1,73,578 sft. i. e. 67.2%. This is satisfactory.

The horizontal and vertical circulation space are within reasonable limits. The area of windows is 20.97% of carpet area.

It seems that the following standards of accommodation have been adopted :—

Head of office.	1028 sft.
Senior Officers.	360 to 684 sft.
Junior Officers.	160 to 250 sft.
Supervisors	60 sft.
Class III.	40 sft.
Class IV.	20 sft.

The space allotment to higher officers is too liberal and could have been reduced without in any way affecting their comfort.

III. *Structural Design and Planning*

The building is founded on Franki Piles, 65′ long and 22″ in diameter, with design load of 100 tons per pile.

The structure is of rivetted steel construction. The possibility of welding does not appear to have been considered. This would have resulted in economy of steel to an extent of about 10%.

The Chief Engineer has, however, stated that welding could not be considered as this technique had not progressed at that time.

The stresses adopted are as per I.S.I. Code.

The Panel observed that the position of stair-cases and lift, provision of lightning conductors, provision of an indicator inside the cage of the lift

were satisfactory and that complete fire fighting arrangements have been installed.

Residential accomodation should not be put up in a multistoreyed structure as valuable potential office space is lost. Arrangements elsewhere would have been less costly.

The Chief Engineer while agreeing with this has stated that the residential accomodation was provided for in this building as desired by the P. & T. authorities.

The external wall of 30" in ground floor and 15" in others is not necessary.

. The Chief Engineer has stated that 30" thickness in ground floor wall was necessary from functional considerations.

IV. *Specifications & Cost :*

The consumption of cement is 2.37 tons per 100 sft. of plinth area. This is high for a steel structure. But it has been explained that it was due to adopting of higher live loads in the designs from functional considerations.

The cost per sft of plinth area works to Rs. 38.14 excluding the cost of foundation. This is high but the building is of special nature and several special requirements of the P & T had to be accounted for.

V. *Execution and Arrangement for Materials.*

The work has taken too much time for completion. As indicated earlier specific responsibility for delay cannot be fixed with the P.W.D. or the contractors employed by it. The building was handed over on 31/7/54 instead of 31/3/53, the date of completion as orginally programmed.

Tests of concrete and mortar have been carried out during the course of execution. There had been no delay in supplying cement. There was, however, some delay in the supply of steel.

7. WEST BENGAL SECRETARIAT BUILDING CALCUTTA

I. *Administrative & Financial.*

The Government of West Bengal took up in March, 1951 the construction of a multistoreyed building to accommodate its various offices scattered over the city at that time. The administrative approval for the work was given as late as March 1952, i.e. about a year after the work was started. The work was let out by negotiation to Messrs. Braithwaite, Burn Jessop & Co. Ltd. The Chief Engineer explained that this procedure was followed as they had decided to adopt the Franki pile foundations since these were considered the best structurally suitable, and the contractors were the sole agents for this type of work.

The work of the foundations started in March 1951. The value of the contract was Rs. 7,16,379/-. It was scheduled to be completed within 5 months, but actually, it took about 9 months. The final bill amounted to Rs. 8,25,371-viz. Rs. 1,08, 992/- in excess of the contract amount.

Four tenders were received for the steel frame work and the lowest was accepted. The work was started on 26/9/1951 and was completed on 28-11-1952, after about 14 months.

Again, for the filler work also no estimates were prepared. Tenders were invited from ten selected firms, out of which only two quoted. It is understood that there was a difference of about Rs. 4 lakhs between the two tenders. The work was awarded to Messrs. Martin Burn, Ltd. for Rs. 23,40,168/- It was started on 4-6-1952 and was scheduled to be completed within 18 months, but the period was exceeded by about 13 months in completion. The amount of the final bill paid to the contractors was Rs. 35,45, 848/- The extra items numbered 187, costing Rs. 12,05,680/-, which works out to 51.5% of the cost of the original quotation. The exeess is extraordinary.

The detailed working estimate of the building portion amounted to Rs.74, 15, 151/- received technical sanction in July, 1955, viz., seven months after the completion of the work.

The remarks above show that in every case it was a postfacto sanction which defeats the very purpose of the preparation of estimates and their approval prior to the start of the work. In such circumstances, there can be no proper control over expenditure.

It has been explained to us that in urgent works which are required to be executed quickly by the administrative department there is perhaps no other alternative but to commence the work before preparation and sanction of the detailed estimate as was done in this case and the practice has the approval of the government.

The delay in the execution of the work has been attributed to:—

(a) excessive time taken by the user departments in supplying the details of space requirements and consequent delay in the supply of drawing.

(b) Interfefence in work on account of several agencies working simultaneously on the project.

The final bill of the contractors was also prepared very late. The pile work was completed in december, 1951 and the final bill was paid in August 1954. The steel work was completed in November 1952 and final payment made in September 1954. the filler work was completed in December 1954 and the final bill in March 1957. Examination shows that the running payments to the contractors have not been regular.

II Space Utilisation:

The building consists of two blocks; one 13 storeyed and the other 6 storeyed. The smaller block is designed to take 4 additional floors at a later date. The building is a steel frame structure with brick filler walls. The total plinth area is 2,81,073 sft. and the carpet area is 1,69,777 sft. i. e. 60. 41%. A higher degree of space utilization could have been secured.

The horizontal and vertical circulation spaces are within reasonable limits.

Office space has been allotted at 400 sft. for heads of offices, 300 sft. for senior officers. and 200 sft. for junior officers. The last two figures could have been reduced to 250 and 160 sft. without any difficulty. The Chief Engineer states that accommodation to the officers is as per the standards of the state Government.

III. Structural Design & Planning:

The building is of corridor type, with 20′ and 32′ bays on either side. Structural frame-work, however, consists of 20′ square grids and the corri-

dor has been carved out of the central span leaving thereby 32′ bay on one side for office staff and 20 ft on the other side for officers. This has been worked out well, and is economical in space utilisation.

It is understood that the strength imparted by the concrete encasing the steel columns and beams, has not been considered in the structural design. It is also stated that the sizes of the beams and columns had to be adjusted to suit the sections already procured by the government for the purpose. Thus, economy in consumption of steel has not received due attention.

The reasons given by the Chief Engineer are that it was not considered worthwhile to take the additional strength of the concrete into account as it may crack due to earthquake, fire or high wind pressure. This, to us, does not appear to be convincing specially in view of the fact that the B. S. Code permits the additional strength imparted by the encasing to be taken into consideration in working out section of the columns.

IV. Specifications & Costs:

Specifications laid down for the building are rational. The outer walls are 10″ thick and partition walls 5″ thick.

The cost of construction comes to Rs. 28.18 per sft. of plinth area including building and internal electrical and sanitary services. This high figure is due to extra foundation cost involved for future extension.

Cement consumption comes to 1.6 tons per 100 sft., Which is slightly higher for the steel frame structure. The consumption of structural steel is 1.03 tons per 100 sft. Consumption of steel reinforcement is also on the high side.

The Chief Engineer admits that the consumption of cement & steel is slightly on the high side due to $2\frac{1}{2}$″ clear cover provided for stanchions, non-availability of correct sections for fish plates, gussets, cleats etc. and additional reinforcements required at corners to prevent cracks.

V. Execution & Arrangement for Materials:

As remarked above, the work was not completed as per original programme.

The quality of work on the whole is good.

8. SECRETARIAT BUILDING, CHANDIGARH.

With the loss of Lahore, the ancient Capital of the Punjab, the State Government of the new Punjab decided to construct a brand new Capital at Chandigarh. In the project estimate for the new Capital, there is a provision of Rs. 122.32 lakhs for the construction of the Secretariat Building, which is to house various offices of the Government. The Building was intended to be a multistorey structure consisting of reinforced concrete frame work and brick filler walls.

2. The State possesses a well-organised Buildings & Roads Branch of the Public Works Department. The Project being of exceptional character and unusual magnitude, the Government appointed Monsieur Corbusier, a well-known French Architect as the Architect Adviser. His remuneration was fixed at 2% of the cost of construction of the Secretariat building. It is understood that in addition he draws a retaining fee.

The main outlines of the structure are the conception of Monsieur Corbusier. The detailed working drawings were, however, prepared by the Senior Architect of the Government, Monsieur Jennaret. The structural designs were drawn out in the design office of the State P. W. D.

3. The space requirements of all Departments that are to be housed in the building were supplied to the Architect in November, 1951. On the basis of these, he prepared the line plans and supplied to the Chief Engineer in July, 1952, after a period of 8 months. These were not adequate for the preparation of a firm estimate. The Chief Engineer, therefore, requested the Architect to supply the usual building plans. In the meantime, however, some changes in the 8th floor of the building became necessary as a result of Government's directive.

Not having received the plans even in January, 1953, the Chief Engineer decided to proceed with construction of the reinforced concrete skeleton work only. A rough estimate incorporating only 14 items was prepared in March 1953, specially for the purpose of inviting tender.

The last date for receipt of tenders was 10/6/1953, but postponement became necessary due to nonreceipt of drawings from the Architect. The tenders were, however, finally received in July, 1953. Lowest tender was accepted. Work was started in September, 1953, but even then, as it appears from the files, the plans were not finalised by the Architect.

The work was scheduled to be completed in 24 months' period, i. e., by September 1955. Actually, however, it took 43 months. The reasons given are the additional work of raft foundation, the cafetaria and the double roof of the terrace. The Team's view is that it should have been possible to foresee these works at the design or at a much earlier stage.

In the course of execution, there were many changes. A large number of new items cropped up. The total number of items in the final bill (which has not yet been paid) is 54 against the original 14.

4. For the purpose of administrative approval, no special estimate seems to have been prepared. It was accorded on the basis of the project provision. Later, however, a rough estimate was prepared on the basis of the plans supplied by the Architectural Adviser, which was submitted to the Government in July, 1955, and administrative approval amounting to Rs. 1,25,70,400/- was accorded on 19-11-1956. For the purpose of the technical sanction, the work of construction of the Secretariat Building has been split up into five components :—

(a) R.C.C. work in foundations.
(b) R.C.C. work in superstructure,
(c) Filler work;
(d) Internal water supply and sanitary installation,
and (e) Electrical and Lift installations.

On the basis of the detailed estimates, technical sanction for items (a) and (b) was accorded on 2-3-1957 and 7-3-1957 for Rs. 20,30,150/- and Rs. 51,87,000/- respectively.

It would be observed that the technical sanction has been accorded after a period of 3½ years from the start of the work. Such *ex post facto* sanctions lose their value and cannot be effective as a means of control over the designs and expenditure.

The R.C.C. work was completed on 31-3-1957. The filler work had not been started even upto October, 1957 when the Panel visited the work, due to lack of decision regarding the positioning of the partitions and doors and windows etc. However, estimates for other items of work such as internal water supply and sanitary installations and electrical installations have been prepared.

From the information that has been possible for the Panel to gather from the files, it appears that the work was started without detailed planning—allocation of space, emplacement of partitions, location of the storage space for permanent records and without finalising structural

service details.

The work was held up several times due to want of architeetural and structural designs. In the absence of complete advance planning, it naturally could not be possible to arrange for all the materials ahead of construction.

5. The work of R.C.C. frame and foundations was completed on 31-3-1957. The final bill has not yet been paid on account of the claims of the contractor. These amount to Rs. 3,44,412/- which comes to 5% of the estimate. The case has been referred to arbitration and the award is awaited.

6. The building is a nine storeyed structure. The height of each floor is 13½ ft. In certain areas, two floors have been combined in order to produce height effect.

7. The basement is as high as 18 ft. The groundsand the approach roads have, however, beeh lowered by heavy excavation to secure a level approach to the basement floor. This substantially adds to the cost.

The building is to be airconditioned, but the arrangements for installation of the plants and ducts have not been conceived. No provision seems to exist in the construction of the frame work.

Even allowing for the room required for airconditioning ducts, a floor height of 13½ ft. for an office building is excessive. Similarly, the floor height of 18 ft. for basement floor appears difficult of justification.

The average height of floor in this case is about 14'. Normally, for office buildings the basement need not be more than 10' (though it may be increased at places to suit functional requirements) and the other floors may be generally 11' high. The average floor height may be 11'—12' at the most. A foot of extra height of floor costs Rs.0.3 to 0.4 per sft. of plinth area. In this case, the extra expenditure on this score can be placed at Rs. 4 lakhs. The liberal heights will further add to the capital as well as running cost of airconditioning.

It has been explained that the building was designed to be usable without air-conditioning and that the heights of floors were fixed accordingly. It has been contended that even if the building was not to be air-conditioned the floor heights could not be less than what has been provided. The proposal of air-conditioning, it is stated, has sprung up much later. It is also stated that the architect still insists that the building need not be air- conditioned.

The Team was, however, informed that it has already been decided to air condition the building. Such an important issue should have been decided at the design stage to obviate the unnecessary expenditure. Even if the building is not to be air-conditioned, the heights of the roofs are excessive.

8. The carpet area of the building is 3.25 lakhs sft. which comes to 54·6% of the plinth area. It is possible to have a higher proportion by better planning.

The effectiveness of the useful carpet area is, however partly vitiated by unsuitable shape of the rooms reserved for officers. It is a norrow rectangle, 12′ wide and 20 to 24′ long. Needless to say that a room of this shape cannot lend itself to full space utilisation. A room of a shape of 12′ x 16′ would have served the purpose equally well. The explanations given are not convincing.

Unfortunately, the size of rooms is dictated by the positioning of the corridor partitions which do not, as a rule, come on the beams.

The corridor is proposed to be of a width of 9′—9″ and is enclosed by 4½″ brick walls on either side resting directly on the RCC slabs. The reasons for the adoption of this design are not clear. It has materially added to the cost of construction due to the following three factors:—

(a) Increase in height of the partition walls as they have to be taken up to the soffit of the slab instead of to the soffit of the beams. This added 2′ to the height of the walls throughout.

(b) Increased cost of frame work due to increase in the dead loads of the slabs designed to take up the concentrated loads of partition walls.

(c) Wastage of space on account of unsuitable shape of the rooms.

9. The horizontal circulation space in the building comprising corridors, verandahs and passages comes to 23.5% of the plinth area. In a well considered design the figure should not be more than 15%. The wastage is the result of provision of verandahs all around the building. The reasons given were that they were necessary for protection against sun. No such verandahs are being provided in Delhi. In any case, thermal insulation could have been secured by other means such as cavity walls or hollow brick or cement tiles.

10. Again the vertical circulation space utilised by lifts, staircases and other vertical means of circulation accounts for 9% of the plinth area. The normal ratio is only 4 to 5% of plinth area.

The high figure relating to vertical circulation is due to the construction of two ramps outside the building. Their provision has been sought to be justified on the ground of saving in the number of elevators provided.

While on the subject, it is also relevant to state that if the ramps were really necessary, their emplacement inside the structure would have produced far greater rigidity and in consequence the ramps could have been of lighter construction. As it is, the placement of the ramps outside the building has necessitated heavy R.C.C. walls.

11. The design does not provide separate accommodation suitable for storage of permanent records. Some experimental record rooms were constructed in the middle of central bay, but the design did not prove suitable.

12. The entire area of both sides of the long faces of the building is glazed. This combined with the orientation of the building has necessitated the provision of elaborate sun protection devices. This has materially added to the cost of the building.

The window and the glazing area comes to 58% of the carpet area of the rooms against the normal proportion of 15% to 20%.

13. The following standard of accommodation has been provided:

Ministers.	750 sft.
Chief secretaries & Financial commissioners.	450 sft.
Secretaries & heads of Departments.	372 sft.
Senior officers.	297 sft.
Junior officers.	249 sft.
Superintendents.	100 sft.
Clerks.	50 sft.

The allowance of 249 square ft. for Junior officer is on the high side. This has been necessitated by the peculiar placing of the partition wall. The Chief Engineer admits that some economy in this direction might have been possible.

14. The grid of the frame-work is nearly square. It is ideal for flat slab construction. This, however, could not be adopted on account of the positioning of the partition walls on the slabs instead of on the beams. The frame work, therfore, had to be of the ordinary beam and slab type.

The frames of the transverse direction have been analysed according to the normal methods of frame analysis. The longitudinal beams have

been designed as continuous ones. Solid cross walls of R.C.C. have been provided at intervals of 100 and 120 ft. to provide necessary bracing against wind pressure. The size of the beams and slabs and other structural members are normal for the loads and stresses assumed in the design.

15. The live load for the office floors has been taken as 80 lbs. per sft. in accordance with the standard laid down by the I.S.I. This figure makes due allowance for the installation of light partition walls directly on the slabs. In the case of the Secretariat building, however, an additional uniformly distributed load of about 80 lbs. per sft. has been added to allow for the placement of brick partition any where on the floor. Positioning of partitions on beams would have avoided the necessity of such heavy loading.

In brief, the position of the partition walls on the slabs, partly the result of the grid system adopted and partly lack of advance planning for space utilisation, had led to heavy additional cost.

The arrangement has been justified on grounds of flexibility, but this must always result in uneconomical designs.

The assumed working stresses for steel and concrete are 18,000 lbs. per sq. in. and 1,000 lbs. per sq. in. respectively. These are in keeping with modern practices.

16. At the time of the inspection only the foundations and framework had been completed. The filler work and installation of other internal services are yet to be taken up. The actual cost of construction is therefore not known.

The cost of framework and foundation alone is Rs. 12/- per sq. ft. of plinth area. The completion cost was not available as the work was still in progress. It is, however. estimated that it may be about Rs. 23/-, which is on the higher side.

17. The following are the figures of consumption of steel and cement for 100 sft. of the plinth area for frame and foundation only.

Steel	0.57 tons.
Cement	1.10 tons.

This is rather high.

In general, the start of the work without adequate planning, has given no advantage. On the other hand, the work has been delayed by

about 10 months, in the course of which, serveral extra items and changes cropped up.

Lack of information at the planning stage has led to oversafe structural designs resulting in increased cost and excessive consumption of materials in short supply.

Lack of planning for the installation of the airconditioning equipment and its ducts may lead to dismantling and disfigurement of the structure and produce the same ugly effect as in the case of High Court building.

Further, such planning does not permit of economical arrangements and collection of materials.

Chandigarh must have consumed thousands of tons of cement and yet it was all carried by the expensive method of gunny bags, and no arrangements for box cart transport and storage silos have been made.

APPENDIX V

Various specifications for thermal insulation and water proofing of roofs adopted in the design of different buildings.

(1)	Multistoreyed Office Building at Queen Victoria Road, New Delhi.	Lime concrete terracing 3″ to 4½″ thick over consolidated cinder from 3″ to 6″ thick and covered with standard 'C' grade malthoid in 5 layers.
(2)	Multistoreyed Office Building at King Edward Road, New Delhi.	Maxphalt painting over slab 7″ mud phuska with brick tiles grouted and pointed with cement mortar 1:3.
(3)	Auditor General and Comptroller of Accounts Office Building, New Delhi.	5″ mud phuska with tile bricks covering cement grouted and pointed with cement mortar 1:3.
(4)	C.B.R. Office Building, New Delhi.	4½″ lime concrete terracing with 1″ gauge brick ballast and mortar 1 lime, 1 surkhi, 1 Jamna sand.
(5)	C.G.O. Building, Parliament Street, New Delhi.	Cinder concrete 6″ thick, Malthoid and two layers of tiles.
(6)	G.P.O. & P&T Office Building Parliament Street New Delhi.	6″ average cinders and two layers of tile bricks in cement mortar 1:3 with sand-witched layer of bitumen in two coats.
(7)	A.I.R. Building, Parliament Street, New Delhi.	Two coats of bitumen (1st coat 40 lbs and 2nd coat 30 lbs per 100 sq. ft.) blinded with sand between two layers of tiles over 8″ average cinders.
(8)	Northern Railway H.Q. Baroda House, New Delhi.	Tarmastic coat, onazote 2″, mud 3″ and tile brick on top.

(9)	I.S.I. Office Building, New Delhi.	Precast concrete chequered tiles over malthoid sheets laid over two coats of hot bitumen and 3" lime concrete over 4" cinders.
(10)	Sachivalaya Building, Bombay.	Gunited to $\frac{3}{4}$" to 1" thick guniting with chicken mesh, over brick-bat coba $4\frac{1}{2}$" thick with water proofing material and cement.
(11)	Income tax Office Building, Bombay.	Cement concrete 1:3:6 laid to slope finished with $1\frac{1}{2}$" thick Indian Patent Stones in panels 4'x4' with bituminous joints.
(12)	Bank/City Exchange Building, Calcutta.	$4\frac{1}{2}$" lime concrete terracing over roof slab consisting of 2 parts lime, 2 parts surkhi and 7 part of brick khoa.

APPENDIX VI

Government of India

Ministry of Works, Housing and Supply.

No. BII--10 (17) / 57 New Delhi, Dated the 30th Nov., 57.

MEMORANDUM

Subject :—Centralisation of Planning and Execution of Civil Works in the Ministry of Works, Housing and Supply.

The undersingned is directed to state that the Government of India have had under consideration the question of centralisation of planning and execution of Civil Works in the Ministry of Works, Housing and Supply with a view to avoiding incorrect budgetting, inadequate scrutiny of works, delay in processing the works projects for sanction, unnecessary lapse of funds etc. The Ministry of Finance accordingly suggested a revised procedure for eliciting the reactions of the various Ministries, the essential features of which are explained below :—

Essential Features.

Stage 1 (Administrative Ministry and their associated Finance)

The Administrative Ministry / Department requiring a work should intimate the administrative requirements to the C. P. W. D. and obtain from that authority the preliminary plans and estimates showing only rough costs, in triplicate, to elucidate the proposal for its examination in its various aspects. The administrative Ministry / Department should examine the proposal accordingly and if the necessity for the work at the rough ceiling cost indicated is accepted, they should accord administrative approval to the work with the concurrence of their associated Finance so that the latter may have an opportunity to examine the justification and the necessity for the work at the ceiling cost indicated.

One set of the preliminary plans and estimates should be returned to the executing agency with a copy of the administrative approval. A copy of the administrative approval with another set of the plans and estimates should be forwarded to W.H. & S, Ministry with other relevant papers, if any. The third set should be retained by the sponsoring Ministry / Department. A copy of the administrative approval should also be en-

dorsed to Audit. These Administrative Approvals, it may be noted, are valid for five years.

Stage II (Ministry of Works, Housing and Supply)

On receipt of the set of the preliminary plans and estimates with the copy of the administrative approval, W.H. & S. Ministry will examine the proposal in consultation with their associated Finance wherever necessary from the point of view of austerity standards, market rates etc., and issue the expenditure sanction after obtaining the comments of C.E., C.P.W.D. if necessary. If, however, Expenditure Finance Committee's approval is required in any case, the sponsoring Ministry / Department will be shown the draft memorandum which will ultimately be placed before the Committee by Ministry of W. H. & S. in consulation with their associated Finance. For the meeting of the Expenditure Finance Committee a representative each of the administrative Ministry / Department and their associated Finance will also be invited to be present. After obtaining the approval of the Expenditure Finance Committee., the Ministry of W. H. & S. will issue the expenditure sanction, a copy of which will also be endorsed to the sponsoring authority for information.

The procedure explained above differs from the existing procedure in this respect that the entire process set forth in stages I and II above was hitherto the responsibilty of the sponsoring authority, whereas under the new procedure the responsibility of the sponsoring authority will be confined to the issue of administrative approval, the remainder being the responsibility of the W. H. S. Ministry. In fact, it is the process involved in the issue expenditure sanction that is responsible for undue delay in taking up works for execution at present.

3. The proposal for centralisation of planning and execution of civil works in the W.H. & S. Ministry was finally discussed at an Inter-Ministerial Meeting on the 11th July 1957, and was unanimously accepted. The Government of India have therefore decided that with effect from the 1st February, 1958, W.H. & S. Ministry should be directly responsible for issue of expenditure sanctions for works sponsored by the various Ministries for which provision is made in the Demands administered by W. H. & S. Ministry i. e. in respect of heads '50-C.W.C.,' 78-Delhi Capital Outlay' and '81 Capital Outlay on Buildings' subject to the exceptions mentioned in paragraph 7 below.

4. As a corollary to the above decision, the procedure for budgetting will be as follows :—

Capital Works all into two categories, viz. (1) Works in progress and (2) New works.

(a) In respect of Works-in progress, the requirements are commun cated to the Ministry of W. H. & S. by the executing agencies, mainl C.P.W-D. by the 15th October each year.

(b) As regards provision of New Works the administrative Ministry/Department will furnish the Ministry of W. H. & S. by the 1st November each year, with a statement of works which have received administrative approval. The works should be arranged in the order of priority. The over-all requirements of the works expenditure including departmental charges will be communicated by W. H. & S. Ministry to the Planning Division of the Ministry of Finance, through their associated Finance by the 10th November each year. After taking into account the availability of resources, the Planning Division will indicate to the W. H. & S. Ministry by the end of November, the funds likely to be available for allocation to the above two categories of works Ministry-wise. Immediately thereafter, the distribution of the provision amongst the individual works sponsored by the various Ministries, will be made after the Works Priority Board of the W.H. & S. Ministry (which will inter alia include representatives from the Ministry of Finance, Planning & Works Divisions) and the administrative Ministry concerned have decided the *Inter se* priority of works.

(c) The distribution statements showing probable allotment of funds for New Works by individual items, and works-in-progress in lump, for the various Ministries will be furnished by W. H. & S. Ministry to the Planning Division of the Ministry of Finance who thereafter will formally communicate the allocation made for the various works to the individual Ministries. Simultaneously they will also send a consolidated copy of the statement of works to the W. H. & S. Ministry. On the basis of this communication which will be received in the Ministry of W. H. & S. by the 10th December, the Demands for Grants showing both the Revised Estimates for the current year and the accepted estimates for the next year will be prepared by W. H. & S. Ministry and forwarded; through their associated Finance, to the Budget Division of the Ministry of Finance by the 31st December of the year together with the accounts circle-wise distribution of the Revised Estimates and the next years' Budget Estimates.

(d) *Revenue Works :* In respect of New Major Works to be included in the Demand for '50-C. W. C.', the Administrative Ministries should second a consolidated statement of requirements to the Ministry of Finance (Works Division) through their accredited Finance. The statement should reach the Ministry of Finance (Works Division) by 10th December each year.

5. *Control over Expenditure-watch of*

Works, Housing & Supply Ministry will keep a close watch over the progress of expenditure on the works with reference to the sanctioned grants through monthly expenditure returns which have already been prescribed. *Inter alia* they will watch the progress in the execution of the works, arrange for reappropriation where necessary in consultation with their associated Finance and Planning Division, and submit a monthly review to the Joint Secretary, Works, Housing & Supply. A copy of this review of progress would also be forwarded to the Ministry of Finance (Works Division & Planning Division). As a result of such review of progress, any instructions deemed necessary will be issued by W. H. & S. Ministry to the C. E., C. P. W. D. with a view to speedy execution of the works in accordance with the provision made in the budget during the budget year.

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7. These decisions, however, do not apply to works sponsored by the Ministry of Rehabilitation, Lok Sabha and Rajya Sabha. In their cases the existing procedure will continue both for 'budgetting and sanctions'.

(M. R. Sachdev)
Secretary to the Government of India

APPENDIX VII

SCHEDULE OF "CONTRACT PERIODS" TO BE FOLLOWD IN THE EXECUTION OF WORKS OF DIFFERENT KINDS AND SIZES.

Description	Period of Construction of Building costing.				
	Upto Rs.5,000/-	Above Rs. 5,000/- to Rs. 2.0 lakhs	Rs. 2.0 lakhs to Rs. 5.0 lakhs	Rs. 5.0 lakhs to Rs. 10.0 lakhs	For every additional work worth Rs. 5.0 lakhs or part thereof.
I. RESIDENTIAL BUILDINGS.					
1. Single storeyed building	4 months		8 months	10 months	2 months
2. Double storeyed building	7 „		11 „	13 „	2 „
3. Double storeyed building with barsati.	8 „		12 „	14 „	2 „
4. Extra period for every additional storey.	3 „		3 „	3 „	2 „
II. NON-RESIDENTIAL BUILDINGS (with load bearing walls)					
1. Single storeyed.	5 „		9 „	11 „	2 „
2. Double storeyed building.	8 „		12 „	14 „	2 „
3. Three storeyed building.	11 „		15 „	17 „	2 „
4. Extra period for every additional storey.	3 „		3 „	3 „	2 „
III. NON-RESIDENTIAL BUILDINGS					
1. R.C.C. framed structure 5 storeyed.	—		16 „	18 „	2 „

	2. Extra period for every additional storey.	—		—		3	„	3	„	2	„
IV.	Levelling the area.	4	„	6	„	9	„	12	„	2	„
V.	Road work.	4	„	6	„	9	„	12	„	3	„
VI.	External water supply work (inclusive the cost of Pipes)	4	„	6	„	8	„	10	„	2	„
VII.	External storm water drainage	4	„	6	„	9	„	12	„	3	„
VIII.	External sewarage.	4	„	6	„	9	„	12	„	3	„
IX.	Internal water supply, sanitary installation and drainage.	3	„	4	„	6	„	8	„	—	
X.	Water works such as reservoirs, filters, settling tanks	6	„	9	„	12	„	15	„	$2\frac{1}{2}$	„
XI.	Sewage disposal works.	6	„	9	„	12	„	15	„	$2\frac{1}{2}$	„